THE NEW AGRICULTURE

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345 ILLUSTRATIONS

THIRD EDITION REVISED

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PREFACE

Several purposes have been in mind while preparing this book: (1) To provide a good text-book which would include the very best and latest scientific developments applicable to agricultural practice. (2) To include the latest and best methods developed by experimental trials at the Stations and Agricultural Colleges. (3) To arrange the subject matter to agree with the project plan of teaching.

A thorough examination of all the recent bulletins from the Experiment Stations, trips to a number of States to investigate special methods in vogue among growers, and other studies have made it possible to include in the present volume many very recent developments regarding planting, harvesting, spraying, fertilizing, feeding, and animal and plant troubles. The number and value of these is indeed surprising and gratifying.

The project plan of teaching agriculture has been so generally adopted and approved that it seems advisable and essential to have an arrangement of the topics and subject matter to conform to this. The order of treatment in each chapter is the same as the steps in the pursuit of the project. The study and the doing are thus linked closely together. Historical and traditional matter is entirely omitted or is offered in small type as "optional" matter.

In treating each subject the arrangement is new, and there are given plans for local unit surveys, problems based upon these, wall charts and placards, debates, field trips, illustrative materials, exercises for the laboratory and land laboratory, projects, and trials with projects. These plans have been evolved as the results of the best teaching and the conferences of the agricultural teachers.

The text is intended primarily for secondary schools; but method of approach, based as it is upon the long experience of the author in training teachers, adapts it to the use of classes in Teachers Colleges and Normal Schools. It not only contains the up-to-date subject matter arranged according to the project approach but it also gives suggestions concerning each enterprise for surveys, problems, charts, pictures, debates, field trips, and projects. Teachers may well be trained by such methods.

The project arrangement of topics and the vast amount of new matter collected should make the book useful in preparing project outlines, in topical assignments, in pursuit of teaching plans, and in otherwise vitalizing the work. If the student does not purchase the book, there should be enough copies of it in the school library so he may have access to the matter here offered.

Job Analysis.—In the SECOND EDITION a full analysis into jobs or teaching units precedes each enterprise chapter. For each job are given page references to this and to other texts, and to bulletins; and local inquiries are suggested. The organization of each enterprise has not been changed. The student is led to study each problem, each job and each enterprise individually and specifically.

The THIRD EDITION includes: (1) Numerous new station findings adapted to farm practices. (2) Corrected data to include recent studies and surveys. (3) Farm mechanics suggestions for each chapter or project. (4) New figures of recent types of animals. (5) Arithmetical calculations for each chapter or project, which teach the values of improved practices.

It is because of the agricultural studies in nearly every State of the Union, the wide reading, the extended writing and editorial work, and his thirty or more years of agricultural and scientific teaching, that the author justifies himself for offering this book to the agricultural teachers and students of America.

ACKNOWLEDGMENTS

Thanks are due to the many Experiment Station experts who have freely assisted in providing the latest matter, methods, and plans to make the book authentic and up-to-date. A number of illustrations are original with the stations. Credit for all illustrations is indicated in each case.

The following agricultural authorities have each read one or more chapters of the manuscript and offered valuable criticisms which have been incorporated for the betterment of the book. Most of these are in actual teaching service: C. F. Alden, Mrs. Grace Allen, O. C. Ault, G. M. Bentley, C. W. Broyles, S. L. Chesnutt, D. M. Clements, M. O. Cooper, W. C. Dickinson, A. F. Elsea, O. L. Farris, C. C. Flannery, S. G. Garner, K. T. Hutchinson, C. H. Lander, T. T. Lindsey, R. S. Maddox, Horace McMurtry, C. M. Miles, E. E. Miller, L. R. Neil, N. D. Peacock, J. S. Pullen, J. M. Shaver, C. N. Stark, H. A. Webb, E. A. Wright.

Mrs. K. C. Davis has read critically the manuscript and page proofs.

Dr. C. H. Lane, Chief of Agricultural Education Service, Federal Board for Vocational Education, has read and criticized the proofs of the entire book.

THE AUTHOR

CONTENTS

CHAPTER		PAGE
	Introduction	1
I.	The Business of Farming	6
II.	Plant Growth and Physiology	22
III.	Projects in Soil Management and Improvement	38
IV.	Corn Enterprise	57
V.	Small Grain Enterprises	85
VI.	Sorghum and Millet Enterprises	119
VII.	Grasses for Hay and Pasture	132
VIII.	Alfalfa Enterprise	149
IX.	Growing the True Clovers	161
X.	Growing Annual Legumes	169
XI.	Irish Potato Enterprise	177
XII.	Sweet Potato Enterprise	191
XIII.	Growing Sugar Beets and Mangels	199
XIV.	Cotton Enterprise	205
XV.	Tobacco Enterprise	219
XVI.	Orchard Enterprise	227
XVII.	Small Fruit Enterprise	257
XVIII.	Garden Enterprise	275
XIX.	Improvement Projects	303
XX.	Woodland Projects	319
XXI.	Swine Enterprise	325
XXII.	Dairy Enterprise	345
XXIII.	Beef Cattle Enterprise	373
XXIV.	Horse and Mule Enterprise	385
XXV.	Sheep Enterprise	399
XXVI.	Poultry Enterprise	411
XXVII.	Beekeeping Enterprise	434
XXVIII.	Power on the Farm	444
XXIX.	Farm Shop Work	452
	Appendix	465

THE NEW AGRICULTURE

INTRODUCTION

The project methods of teaching have secured a firm hold and have become fairly well established in American education. Teachers of agriculture were probably the first of all to adopt the project plan of instruction. In connection with the teaching of agriculture the term "project" has a somewhat definite meaning and relates to the pursuit of a well-planned undertaking which is to continue for a season or other extended period of time.

When projects are undertaken by students they should relate to the occupations of the region. In newly settled sections projects entirely new to the region are sometimes started with a hope that they may prove valuable for the locality. The choice of a project to be pursued by a student during his school life should be interesting and related to his school studies. It should be largely new to the student and suited to the student's physical, mental, and managerial abilities, suited to the soil, climate and equipment of the place and to the markets. It should have a good money return or prospect.

The objects of a project should be: (1) To interest the student; (2) to interest the parent; (3) to aid the student financially; (4) to make his agricultural studies more purposeful, concrete and tangible in effect; (5) to give him opportunity to apply such related subjects as the sciences, English and mathematics; (6) to develop his skills; (7) to teach methods of procedure; (8) to develop managerial ability; (9) to train in record keeping; (10) to broaden his civic views.

Classes of Projects.—All projects may be classified into two main kinds: (a) The individual project, where one student conducts his own enterprise or project independent of other students; (b) the group project, in which several students or a whole class coöperate in the undertaking.

Projects may be classified also as to their aims into the following groups: (a) Productive projects, pursued to learn methods and gain skills and also to produce an agricultural product for profit.

(b) Trial projects in which certain methods or practices are compared and tested or demonstrated, both for the sake of the student and for others seeing the results. (c) Improvement projects, pursued for the purpose of enhancing the value of property or making surroundings more convenient and livable for those concerned. (d) Management projects, pursued for practice, skill, and development along managerial lines.

The terms major and minor are often applied to projects. Major projects are those which students or others pursue, usually along productive lines, the chief activity being centred upon it. A minor project may be (1) a part of a major project, as the sale of dairy products in a major dairy enterprise. It may be (2) a small or short-time project such as the feeding of several crates of broilers for market. (3) A project that has been taken as a "major" and continued the next year may be considered as a minor project. Major projects are not always more remunerative, the reverse may be true.

Home projects in agriculture are often pursued by students studying the subject in school. The instructor directs or coaches the student in the planning and pursuit of his project and the student performs his regular studies in connection with the project while he is studying agriculture in school. Suppose, for example. that a student plans a swine project, such as any one of those suggested in Chapter XXI. The pursuit of the project will keep the student's mind upon the daily routine of work and management and will keep his mind active along practical lines while he is studying the assigned topics in his regular school work.

To secure the greatest benefit from a home project a student must, of course, choose a home project which is more or less new to him or in which the methods to be followed and the skills practised are different from those to which he has been accustomed.

Parents and pupils, as well as the instructor, should all agree regarding the general plan of the project; the scope as to length of time; the number of animals or acres of crop; the phases of work to be covered; the trials or demonstrations to be included.

The home project, to be most helpful to the student, should be well supervised by the instructor or some other competent person who can coach the student regarding general methods, and many special methods when difficulties arise. The supervisor should be present when new skills are to be learned and should direct the student in these.

A project should be carried through its entire cycle to comple-

tion. Some projects require more than one year. These should be continued so that students may grow into the business of farming.

Records regarding the details of the project should be kept regularly and systematically by the student. These should include all records of time, methods used, labor employed, cost of materials used, allowances made for implements, and for horses or other power. The record should also show the yields from the project, whether it be a crop project or a livestock project. The record should show the income from the disposal of the crops. From these

FIG. 1.—Project boy asking his instructor for suggestions regarding his record book. (Florida Station.)

the calculations as to the labor income and the net income should be made. (Fig. 1.)

Class-room Discussions.—During the pursuit of the project, methods being followed, difficulties which arise, special problems which are involved, and any other points of value should be discussed by the student in class at school. Each member in the class may thus bring to the class-room conference many valuable points from his own project experience. Members of the class may aid in solving problems for each other. It is better, therefore, that members of the class pursue several different kinds of projects rather than that all plan the same kind.

Project Report.—At the close of a project each student should write a comprehensive account of the entire enterprise: The plan of inception; the equipment, materials or stock involved; the steps

followed; the difficulties arising at any of these steps; how difficulties were surmounted: what records have been kept; what returns have been secured; what benefits have arisen from the pursuit of the project by the student; the opinion of the student regarding the pursuit of such a project as a vocation or avocation.

Planning the Project.—A student should plan all details or steps to be involved in the project before it is undertaken. This causes him to have a clear insight into the main elements of the undertaking before he goes too far with the operations. He may thus be prevented from attempting something which would involve conditions which he cannot meet because of special surroundings. When the plan is made in advance it helps both the student and instructor to know what is to be the progress of the work. The parent will also know what is expected of the student. Planning the steps in advance does not mean that they may not be varied to suit new conditions that arise from time to time in the progress of the work. Weather conditions, market prices, insect enemies, storms, and other factors may influence the order of procedure. In order to plan the details of the project the student should make a cursory study of the main steps such as are suggested in paragraph headings in a book or chapter upon the subject. He should have access to several reference books upon the same general subject to aid him in outlining the work. The instructor will be able to suggest to him a rearrangement of some of the steps in his outline after he has nearly completed it.

Project studies and job analyses will be made in detail while the work is in progress. Each job of the project is to be analyzed in a project book. A good plan is to have a wide page divided into three columns. In the first column are placed the steps or jobs, in the second column are topics for study or job analysis, and in the third column place the references opposite each topic. The references may be to certain pages or chapters in text and reference books, and to bulletins.

Record blanks and forms are usually obtainable from state departments of education or from publishers.

Project Equipment.—Students who do not live upon farms may be able to secure the use of land, work animals, and other equipment from neighboring farmers for the purpose. Either cash rent may be allowed for land and implements or a share in the proceeds may be agreed upon in advance. Work animals may be hired, but livestock eventually to be killed or sold should be purchased by the students.

Difficulties sometimes arise in financing the project. If parents are unable for any reason to supply equipment, such as seeds, fertilizers, livestock, feeds and implements, other provisions will have to be made. Bankers, merchants, and other business men often freely advance funds for the purpose. Breeding animals are sometimes directly supplied by them. For example, in some cases eggs are furnished on condition that a certain number of pullets be returned in the fall. Pigs are supplied at the beginning of the year to be paid back in kind at the end of the project.

Other Helps.—Whether or not high school students pursue projects, the instruction can be made more concrete and practical by frequent field trips, laboratory exercises, outdoor demonstrations, community unit surveys, and arithmetical problems based upon surveys and farm management. Every student should carry a series of individual farm and shop practices that relate to the projects. Much interest can be added to the class exercises by the making of charts and placards. Debates and discussions should be used to arouse thought and interest in practical undertakings of farmers. Much reading and writing will make the student more careful and exact in his knowledge of many topics.

The topical method of assigning work will make the student more willing to perform his daily task than page or chapter assignments. The topics in each chapter of this book have been arranged somewhat in order of project sequence, that is, the headings of paragraphs or the subjects of discussion are somewhat in the same order in which they would naturally follow in the operations of the project. These must, of course, be somewhat rearranged to suit particular conditions. One project may start at one place and another earlier or later.

References.—Bulletins of U. S. Federal Board for Vocational Education relating to Agriculture:

56. Animal production.
68. Course in swine.
74. Analyzing potato enterprise.
75. Analyzing poultry enterprise.
91. Job lesson units in truck and fruit.
101. Analysis of management jobs in corn-growing enterprise.
105. Analysis of management jobs in cotton-growing enterprise.
112. Supervised practice, home projects.
115. Training for leadership in agricultural education.
117. Agricultural project planning.
118. Analysis of operative jobs in corn enterprise.

CHAPTER I

THE BUSINESS OF FARMING

SOMEONE has said that farming should be only one-half growing of crops and the other half business. Too often the producer is guilty of poor management, poor marketing, fails to keep accounts and records, and is a poor business man in other ways.

Increases in prices of land, the invention of new implements, the advent of tractors and other gas motors and the increased cost of labor, all demand that the farmer give more attention to the business side of his enterprise.

A High Calling.—Modern farming demands men with good education, good business training, and those in every way prepared for their chosen work. Fundamental sciences should be well understood. A knowledge of plant and animal life, principles of breeding, and improvement, a knowledge of world affairs and a clear insight into market conditions, skill in farm operations and mechanical manipulation, close business application, steadiness and willingness to do the right thing at the proper time, attention to details, physical strength and endurance, courage to venture, confidence in the future—such is the call of the modern farm, which can be heard in all parts of America.

Getting Started in Farming.—The pursuit of farm projects while attending school is one of the best ways of securing training under the guidance of good instructors. Methods, skills, and applications of principles are thus learned and they should be learned well. But after this, how are you to get possession of a farm to apply your knowledge and training? Several plans present themselves: (1) Renting a farm on shares or on cash payments to be made at the end of the year; (2) borrowing capital for the purchase of a farm; (3) following some other calling and using it as a stepping stone to farming; (4) running the home place on shares or as one of the heirs or while making a home for your parents.

The renting plan has many attractions to the beginner and if the farmer is determined to succeed and to purchase that or some other farm, he is likely to succeed when he starts this plan. Too often, however, he is satisfied to remain a renter all his life, never gets ahead and never has a place of his own. He learns to depend upon the capital of the landlord for operating expenses or he starts the credit system of living. The tale from there on is a woeful one.

Many a well-to-do farmer, however, can be found who made his start by renting a farm for cash to be paid near the end of

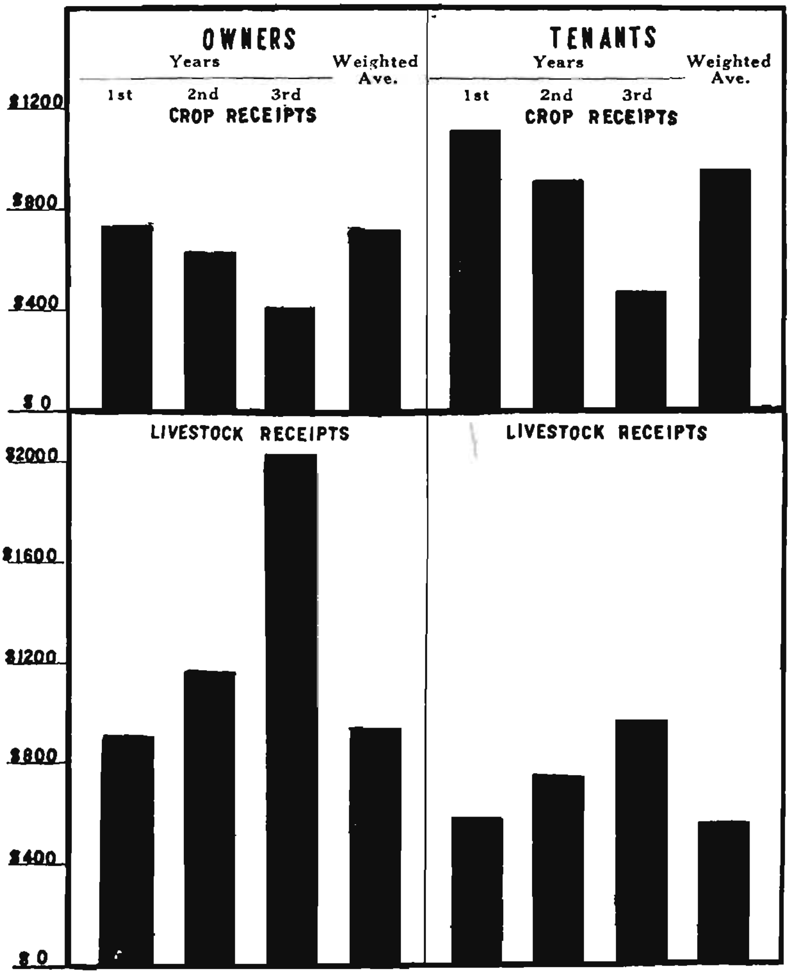


FIG. 2.—Comparison of sources of receipts of owners and of tenants of Kansas farms. Note that the receipts from crops usually exceed the receipts from livestock, on the tenant farms, while the reverse is true on farms operated by owners. The tenant's lack of livestock must ultimately result in depleted soil fertility on rented farms. (Kansas Station.)

the summer. This plan holds out an inducement to succeed and all his extra efforts will yield returns to his own account. (Fig. 2.)

The share system is not a profitable one for the American landlord when tenants are moving frequently and each is robbing

the soil to the last bit of plant food. Neither is it a profitable plan for the tenant, as extra effort made by him is to be shared with the landlord. This induces idleness; self contentment; shiftlessness; impoverishment of soil; itineracy; lack of interest in roads, schools, churches and other community affairs. If you rent a farm on the shares plan, have a clause in the contract, by which you are to have the surplus for extra undertakings. For example, if you stock the farm with cattle or hogs you should have the increase from these if the farm gets the fertility from the manure. Long-term leases should be preferred to short-term leases both by yourself and by the owner.

The Stepping-stone Plan.—A clerkship, teaching school, a mechanical job in a shop, a farm job, or some other wage position is often taken by a young man who fully intends after a while to start into farming. The difficulty is that his mind may be trained away from scientific farming. He is unable to keep up his interest in modern agriculture and so many opportunities are offered in cities for the spending of money, that his ideal is seldom reached. While he is pursuing such work, he should start a systematic saving plan and follow it rigidly. He should also regularly read agricultural bulletins and periodicals, and perhaps pursue agricultural courses in Saturday classes or night classes if such are available.

Going into Debt.—The national farm loan provisions have reduced rates of interest on money invested in farm lands and farm enterprises so that any well-trained person can readily meet the payments under the amortization plans offered to farmers under the national law. If a young man wishes to buy a farm he may borrow money on the proposed farm and give the seller of the farm a second mortgage for the balance. If the second mortgage comes due first the seller is protected and very little original capital may be necessary on the part of the purchaser. If such a farm is already equipped, the buyer can, by careful management and industry, apply modern methods and regularly meet his payments.

Choosing a Farm.—When selecting a farm several considerations should be made: (1) Roads and distances to market; (2) kinds of markets; (3) schools; (4) churches; (5) community organizations or coöperative associations; (6) taxes; (7) labor supply; (8) prosperity of community.

Besides these general points about farms of the region one should also consider the following about the farm in particular: (1) Suitability of soil for the crops desired; (2) topography of surfaces; (3) plan of the fields; (4) location of buildings with reference to fields; (5) nearness and character of neighbors. As

you go about from farm to farm classify them in your mind for particular purposes as for dairying, swine raising, grain farming, fruit growing, trucking, and other types of farming.

Size of Farm.—There is usually a close relationship existing between the size of the farm and the net income (Figs. 8 and 9), but this holds true only within certain types of farming. For example, a large grain farm should give greater returns than a

Fig. 3.—Mississippi trucking. Gross cost of producing one acre. (Mississippi Station.)

small grain farm, but when the type of farming changes, size naturally changes. For example, a truck farm of twenty acres may give greater net returns than a general farm of one hundred acres.

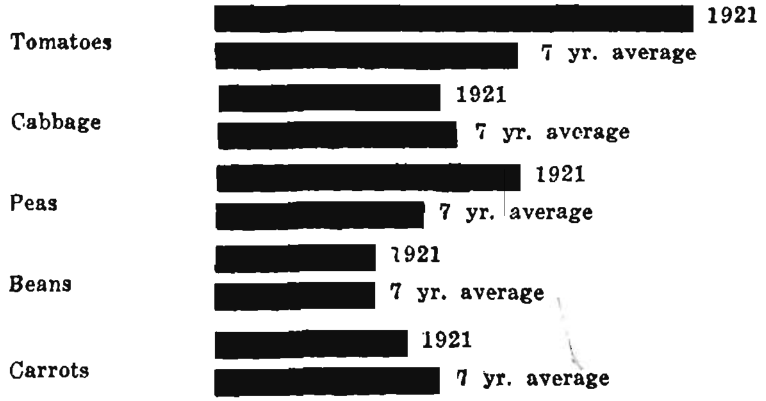


Fig. 4.—Mississippi trucking sales from one acre 1921 and 7 year average compared. (Mississippi Station.)

The size you select should depend upon the type of farming you intend to follow.

The beginner often finds it advisable to purchase a small farm at first and add more acres to it later on. Perhaps the additional acres desired may be rented with the privilege of purchasing later.

Types of Farming.—Special lines of farming are usually most successful and are, therefore, a great temptation to beginners and others. The old adage of "carrying all your eggs to market in

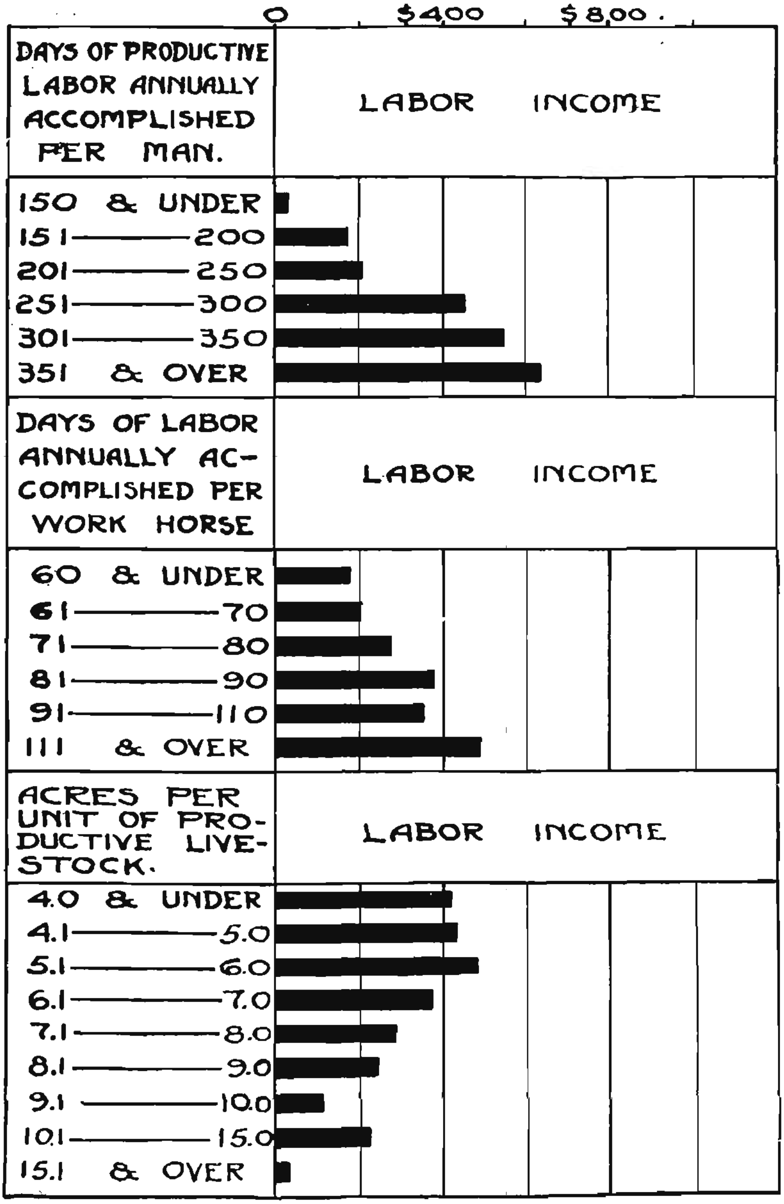


Fig. 7.—Summary of relation of important efficiency factors to labor income. (University of Minnesota Survey in one county.)

the investment, the annual repairs, the annual deterioration, considering the machine will last about eight years. Now remember that the corn must still be shocked by hand and that much of the

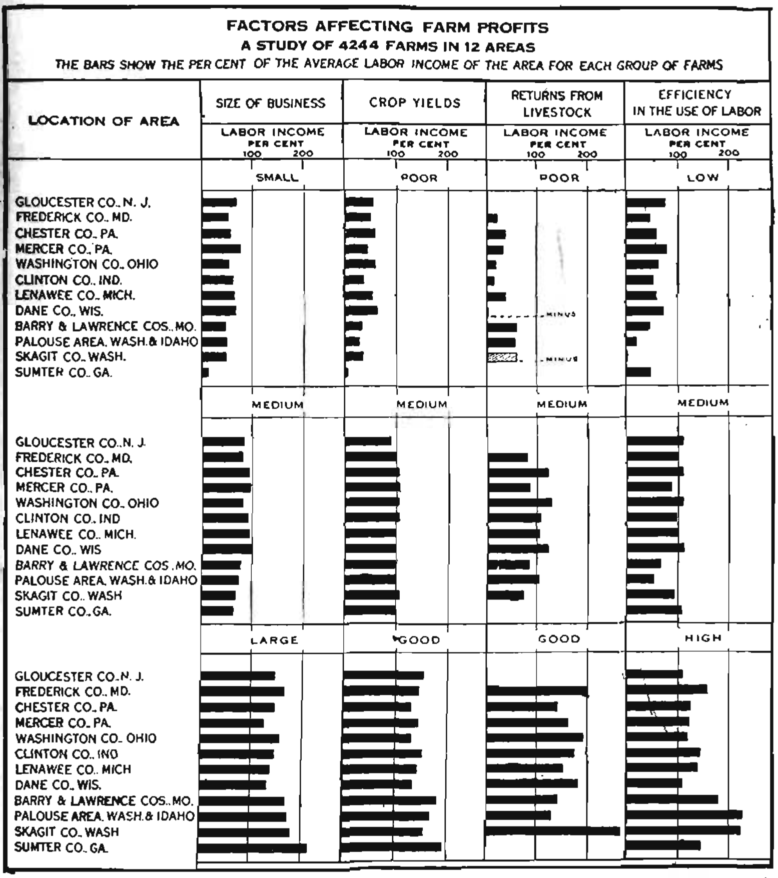


Fig. 8.—Factors affecting farm profits. (U. S. Farmer's Bulletin 1139.)

corn cut with the binder is wasted in the field if winds have been severe. Consider the difficulty of securing labor and of having the crop cut on time.

If the beginner carefully weighs both sides of the question he is not likely to go wrong in over-equipping his farm. In many cases the question of the owner's ability in managing his place is involved in questions of equipment. For example, some farmers

have purchased tractors but by poor management have been unable to make them more profitable than the use of horse labor. In other instances the purchase of the tractor has resulted in double-cropping of fields annually. A tractor can be used immediately after harvest. When the weather is hot it may be used at night as well as by day to hasten the preparation of soil for the next crop. Tractor owners thus often raise silage corn, and summer hay crops after grain harvest.

Economy of Labor.—Both man labor and horse labor should be used economically throughout the year. (Figs. 6 to 9.) It does not pay to employ horses and men for work which is non-productive and will not lead to improvements and profits. Too often the careless manager employs labor by the month and directs the work only from day to day with little forethought as to profitable results. This not only has a detrimental effect upon the farm income, but it actually has a detrimental effect upon the morale of laborers. They naturally want to see good results from their labor. The manager should show them his motive in performing each piece of work. Laborers of very low intelligence will usually respond better to managers who enlist their interest in their labor.

For rainy days and cold weather provide work which will count. The overhauling of machinery, the painting of wagons, the greasing of harness, whitewashing interiors, repairing of buildings, are good for such occasions. Select the most important first.

Farm surveys have shown that farm horses are idle too much of the time for profit. Some farmers take wood cutting and hauling contracts for the purpose of employing horse labor during the dull season. Others obtain team work in unloading freight cars of fuel, lumber and other building materials. Others take contracts in excavation, road building or work for near-by factories of various kinds.

Farm Wastes.—On farms used for special enterprises there are often many wastes which should be used. Pigs kept on a market garden farm may consume many such wastes. Sheep kept on most general farms may be used to graze along fences, on cut-over fields, in weedy pastures or in other places. On a beef farm a few hogs running behind fattening animals will consume wastes and gain in weight. A poultry flock may glean most of its feed from farm wastes and destroy many insects and weed seeds. The farm manager should plan to use all such wastes to best advantage. He should not be guilty of allowing the barnyard manure to accu-

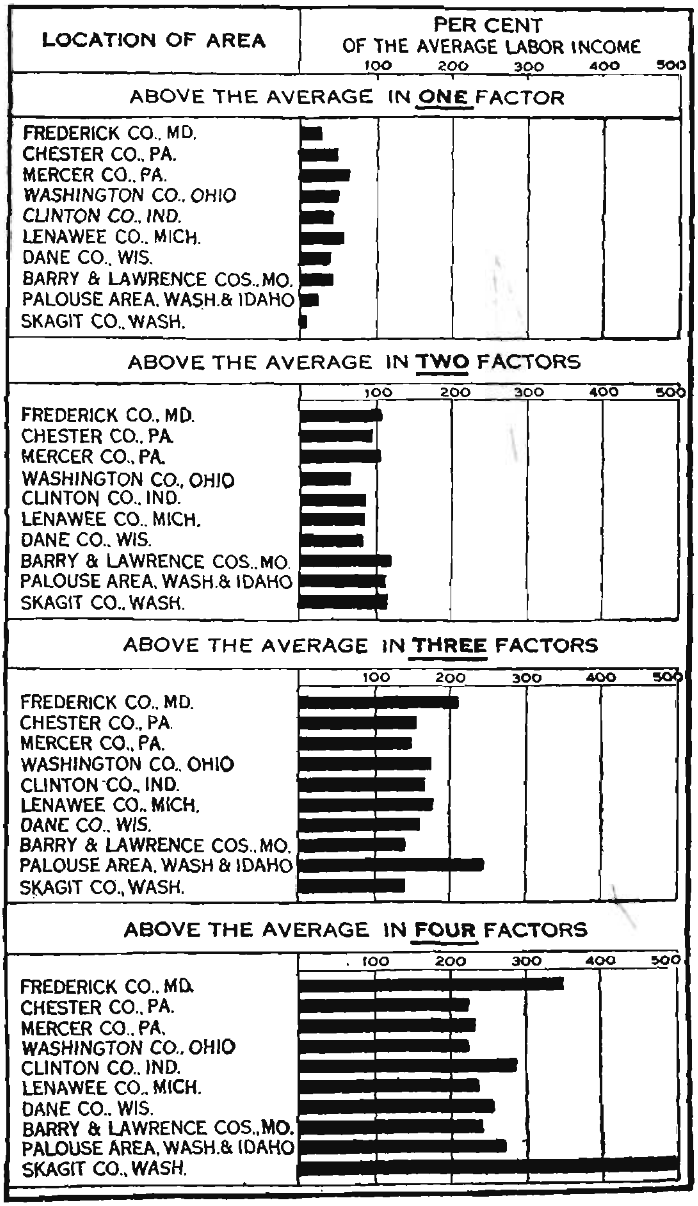


FIG. 9.—A comparison of farm profits when one, two, three and all four of the factors are above the average of the area. The factors are: size of business, crop yields, returns from livestock, efficiency in the use of labor. (U. S. Farmer's Bulletin 1139.)

mulate in piles where it will leach or heat, but should frequently move it to fields.

Losses on the Farm.—The young agriculturist is appalled as he sees the terrible wastes on farms about him. He should resolve that when he gets into the farming business for himself he will eliminate all losses so far as it is within his power. Preventable losses: Nine-tenths of the diseases of farm animals; the feeding of non-productive dairy cows; the keeping of non-laying hens; the keeping of old beef animals; the partial or total failure of many crops; the weathering of machines; the gullying of fields; many fires; the losses from insects and plant diseases; the killing of beneficial birds: the wastes from rabbits, rats and mice; the molding of hay and fodder; other spoiling of stored products.

The Farmer as a Salesman.—Salesmanship is the most important part of the business of farming. Good salesmanship in farming does not mean that the producer must be a good talker to sell his products well. Several other elements enter into the problem: (1) The sorting, for the sake of uniformity, of such products as calves, pigs, chickens, eggs, vegetables and fruits. (2) Offering of products in attractive forms—good containers, clean appearance, attractive colors, good wrappers. (3) Planning in advance to meet special markets and good prices. Every feeder or other farmer should realize the importance of this element in marketing. (4) Coöperate with other producers having similar products so that the combined lot of products may be placed in proper markets, may be marketed in larger quantities and may be graded more uniformly for all. (5) Coöperate for the sake of locating the best markets. Associations can better afford to seek out the best markets for a given product than can a single producer. (6) The production of varieties which will best meet high market standards. (7) Good advertising including the name of the farm and its special products. (8) Coöperate in increasing market demands for certain products.

System in Farming.—One of the most important elements in successful farm management is to have all farm operations systematically conducted. The best manager does not work day by day but plans ahead and knows just when a job is to take place or when a piece of work is to be completed. He not only plans his crop rotations definitely but he provides well for all emergencies likely to arise therein. He keeps clearly in mind all steps in each operation and carefully directs labor in the performance of those steps. He calculates closely the proper time for breeding to meet certain

markets, the proper times for spraying to prevent certain troubles, the best marketing dates for certain products, the right amount of labor to use for certain undertakings, and the best methods of marketing to get the best prices. The poor manager falls short in many of these and other requirements. He has no system. He performs the work first in sight and does not look ahead.

Farm Management Investigations.—The farm manager has many difficult problems to solve. He should look ahead for these

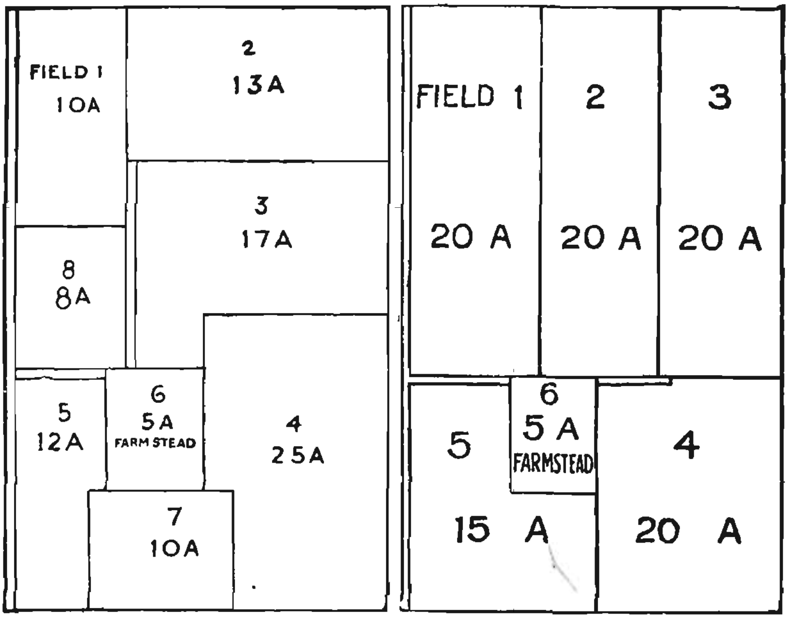


Fig. 10.—Left, plan of actual farm, too much cut up and fields not well arranged. Right, the same replanned to save distance to fields and to save fence material. (Agriculture and Life.)

and have them in his own mind, at least, when the crucial time comes. Several examples are given here: (1) How to make farm labor better contented and more interested in the progress of the work. (2) How to manage ignorant and unskilful workers. (3) How to secure better farm help. (4) How to systematize the care of implements and tools. (5) The management of farm manure for least loss and with least labor. (6) Securing good results from team work without hurting the horses. (7) Preventing sore shoulders in plowing season. (8) The elimination of unprofitable lines of farming. (9) What new sides lines to undertake. (10) Equip-

ment problems. (11) Teaching dairymen to treat cows well. (12) Simplifying farm book-keeping.

Farm Accounting.—Failure to keep farm accounts is probably the greatest criticism against farmers of the present time. Too many farmers are unbusiness-like and guess at results. When they are asked to testify regarding the cost of producing certain crops or animal products they have no data with which to fortify their opinions.

Reasons for Keeping Accounts.—(1) Keeping accounts will show the farmer what lines of farming are most profitable to him; (2) will aid in eliminating unproductive animals or crops from his business; (3) will let him know before the end of the year about how he is coming out; (4) will show the amount of capital required for the enterprise and labor next time; (5) will cause him to figure closely on all elements of cost in production; (6) will enable him to distinguish between labor income and net profit; (7) will record bills owed by or to the farm; (8) will record yields of crops on certain fields; (9) will record amount of feed used; (10) will aid the farmer when soliciting loans.

Kinds of Accounts to Keep.—Each special line of farming may have an account of its own. The poultry department, for example, should keep records of feed purchased, and labor used, and other articles purchased, and of the production of laying hens, the records of hatching, the sales and prices.

The dairy department should keep monthly records of yields from individual cows and feed consumed. All livestock departments should keep records of breeding dates and births, feed purchased, products sold and labor used. Keep separate accounts for beef, swine, and sheep.

Keep also separate accounts for each of the following: Cash, labor, feed, supplies, crops of each kind. In keeping a crop record, for example, charge up to the field the fertilizer, man and horse labor, seed, and use of implements. Credit the account with yields of the crop and any gleaning by pasturing with livestock.

At the end of each year balance up each account even if it has been balanced each month. If possible open new accounts each year.

Memorandum.—Many occurrences on the farm should be recorded in a memorandum book. (1) Dates and points of verbal agreements made with neighbors. (2) Dates of first fall frosts. (3) Dates of heavy late spring frosts. (4) Blossoming dates of different fruits. (5) Important purchases or sales. (6) Records of extremely high or low market reports. (7) Time and expense

of filling a silo or similar important operations. (8) Dates of purchasing certain machines, with prices. (9) Breeding dates, births and deaths. (See Farmers' Bulletin 782.)

Form of Accounts.—Records are likely to be kept better if the forms are simple. Each item should be entered only once. This plan requires less time and is, therefore, more economical. Make them so simple that a boy or girl can be taught to enter the items when directed.

Special rulings are expensive and books with standard ruling may be purchased at ten-cent stores. Books ruled by the column system provide a column for each account and these columns are side by side on the open page which has one horizontal line for each day of the month. Charges may be entered in one color and credits in another color, or two columns may be used for each account, one for charges and the other for credits. (See Farmers' Bulletins 511 and 572.)

Inventory.—At the first of each business year, perhaps about March 1, the farmer should make a list of his entire equipment with values opposite each item. This is not for publication but for his own use. It should be kept with his most valuable papers. The first year will take longer than others years. Include all the things the farm owns and all debts and liabilities of the farm. Include the land, buildings, livestock, machinery, feed and products on hand, and household goods. Each year correct the values of all items when the new inventory is made. Such an inventory will serve as a good guide to the farmer, will serve him as a basis of legal claim in case of fire, will serve in fixing amounts of insurance carried and will aid in acquiring loans.

Field Trips, Exercises, Projects and Problems

1. **Farm Management Surveys.**—Farm management includes so much that a survey covering all phases is extremely long and laborious. It requires many pages of data. Farmers sometimes object to answering so many questions at one time.

Small unit surveys are better. Choose one special line of farming at a time. The surveys made for each of the special phases of farming suggested at the close of each chapter in this book will give much farm management data. The management features can be gleaned from these. If a few additional points of information are desired make a brief questionnaire to cover them.

2. **Farm Management Problems.**—(1) Calculate the cost of raising beef calves running with their mothers and compare this with the cost of raising dairy calves by hand. (2) Calculate the cost of raising mule colts to age of two years and other colts to three years. (3) Calculate the losses for one year on an average farm of your region. (4) Find the labor income for one or more farms of your region. (5) Calculate the cost of producing small grain or cotton or milk or other important products of your region.

3. **Farm management charts** of many kinds may be made. A few are suggested: One should be made on each of the problems just suggested. Make a chart of the column system for farm book-keeping. Make another chart showing items in a typical farm inventory. On another chart show items of net income for the main enterprise and for each of the side lines.

4. **Farm Debates.**—"Borrowing money *vs.* renting land to start farming." "Pure-bred *vs.* grade livestock." "Farm book-keeping *vs.* guessing methods." "Losses in farming *vs.* losses in business." Debate the location of farm buildings; equipment questions; terracing and cover crop problems; coöperative ownership of expensive farm implements; coöperative ownership of sires and coöperative selling of livestock or other products.

5. **Farm Management Trips.**—Visit farms where special enterprises are in progress to study the special problems in management. Large plantations may be visited to study special problems of equipment and labor. Find the best and the weakest points in management at each place. Study the work of marketing associations at the height of their seasons or at other times. Visit coöperative creameries, coöperative feeding places and other similar undertakings. Visit markets to learn methods of preparing products, to study details of selling and to learn the methods of middlemen. Go to warehouses, elevators, cold-storage plants, packing houses, and similar places to study factors involved in holding products and in securing buyers.

6. **Exercises.**—(1) Make plans of actual farmsteads of the region showing arrangement of buildings, wells, roads, walks and fence lines. Replan the worst of these (Fig. 10). (2) On an unequipped farm make an ideal plan which will be practical for the place. (3) Plan field crop rotations suitable for the region. Draw the fields and write in the crops. (4) Draw several pig pastures and write in each the pasture crops, giving dates for planting and dates for pasturing each. Make them supply green feed throughout the year if possible. (5) Make application for registration of pure-bred livestock for the breeds of your region. (6) Draw and practise keeping records of laying flocks, individual dairy cows, feeding lots of swine and beef cattle. (7) Practise cost accounting for various farm projects. (8) Practise filling and using business forms, such as deeds, leases, insurance papers, mortgages, contracts, receipts, checks and notes. (9) Practise reading from deeds the land descriptions and drawing the boundaries of land on paper from the deeds. (10) Learn to figure labor income, net income, costs of production, pay rolls for creameries, for egg circles, shipping associations, fruit packing plants or any similar enterprises of the region.

7. **Farm Management Projects.**—Students often conduct special management problems in connection with various crop and livestock enterprises. Independent farm management projects may be planned along various lines. Twenty of these are suggested in *How to Teach Agriculture*, Storm and Davis, p. 295.

8. **Job Analysis.**—Write a list of the points to be considered in analyzing some of the managerial jobs suggested by this chapter: (1) Choosing a farm; (2) securing capital for farming; (3) purchase of equipment; (4) employment of farm help; (5) selling the products of my project; (6) what accounts to keep on my farm.

Questions and Investigations

1. Why do most farmers not keep accounts?
2. Why are so many farmers poor in marketing?
3. What recent conditions have made the business side of farming more important than formerly?
4. Tell of at least two cases showing how farmers have started into farming for themselves.

5. Discuss share renting *vs.* cash renting.
6. Discuss renting *vs.* borrowing and buying.
7. Give arguments for and against the stepping-stone plan.
8. Give general and particular points to be used in choosing a farm.
9. What sizes of farms are common in your region? Look up the average.
10. Mention area you would want for poultry; for an orchard; for general farming.
11. Discuss special farming *vs.* general farming.
12. Give examples of poor economy in equipping farms.
13. What plans can you make for the economical use of teams and hired hands during rainy and wintry weather?
14. List ten kinds of farm wastes you have seen.
15. How can a farmer become a better salesman?
16. Discuss the importance of system in farming.
17. Give a list of investigations the farm manager should make.
18. Give ten reasons for keeping farm accounts.
19. What kinds of accounts should be kept?
20. What kinds of entries would you make in a memorandum book?
21. Describe a simple form for keeping accounts.
22. Tell how to make an inventory. Give uses.

U. S. Farmers' bulletins relating to the topics of this chapter should be secured by each student: 511, Farm book-keeping; 572, Cost accounting; 1042, Labor-saving practices; 1088, Selecting a farm; 1139, Analyzing farm business; 1164, Farm leases; 1182, Farm inventories; 1614, Poultry records. U. S. Farmers' bulletins on marketing: 1050, New potatoes; 1055, Hides; 1080, Apples; 1144, Coöperation; 1145, Cantaloupes; 1204, Apple packing; 1210, Timber; 1232, Seed; 1266, Peaches; 1502, Livestock shipping; 1551, Parcels post; 1553, Expenditures; 1558, Grapes; 1560, Strawberries; 1564, Farm budgeting; 1578, Late potatoes; 1579, Fruits and vegetables; 1594, Bunched vegetables.

Recent reference books on farm management, marketing, etc.: App (Lippincott, 1928); Boyle (Lippincott, 1928); Macklin, Grimes, Kolb (Ginn, 1927); McKay and Lane (Wiley, 1928); Mears and Tabriner (Ginn, 1926); Overton and Robertson (Lippincott, 1929); Yoder (Crowell, 1929).

Things to Make.—Students should plan at school to make many useful articles to use with their home farm practice work. For the business side of farming a room at home for an office, or office space in the family living-room, should be equipped. Provide a table or desk, book shelves for the back of the table, bookcase, pamphlet holders, filing case, typewriter table, radio case, etc. Make a farm bulletin board on which to list articles offered for sale. Make a sign-board with the farm name. Erect a roadside market shed with shelves and devices. See other lists for each farm project. Much shop work may be done at home.

Calculations.—1. A farmer who produced much of his family living on the farm found, by his records, that his sales had exceeded his purchases for the farm by $1,276. His daughter kept records of family living produced from the farm, on the basis of city prices, as follows: Rent above taxes, $480; table supplies from field, orchard and garden, $216; from poultry, $72; from dairy, $103; from swine and sheep, $204; horses in going to church, school, etc., $300; fuel, $85. Find the total labor income from the farm.

2. In problem 1 what percentage of the labor income was represented by the net sales?

CHAPTER II

PLANT GROWTH AND PHYSIOLOGY

THE successful growth of plants for agricultural purposes depends upon having all conditions as nearly perfect as possible. As animal growth is dependent upon plant production it is natural to infer that both animal husbandry and crop production depend upon a few essential conditions necessary to maintain and nourish plants.

Conditions for Plant Growth.—There are six chief needs of plants to be considered: (1) Warmth or other proper temperature. (2) Moisture in an available form. (3) An available food supply. (4) Oxygen in the atmosphere and soil air. (5) Sunlight. (6) Freedom from injurious insects, diseases, and other enemies. These will be considered briefly for the purpose of calling attention to the essentials underlying crop production.

I. Proper Temperatures for Growth.—We often find conditions too hot or too cold for the perfect growth of crops. The length of time through which the best temperatures prevail in a given season or region will determine the limits of crop production there. Some plants grow in very cold climates, but most of the agricultural crops which concern American farmers require summers of moderate temperature. In the treatment of each of the crops studied in this book, the hardiness against frost and the dangers of extreme heat or cold are given. It is indeed surprising to find such a wide range regarding warmth requirements of fruits, vegetables, and field crops. The small grains endure much more cold than corn and sorghum. The latter crops must be produced between spring and fall frosts. Small grains endure winter cold in rigorous climates and germination may take place in soils as low as forty or fifty degrees F. Certain garden seeds will germinate at those low temperatures, while okra, melons, corn and other warm weather crops must have warm soil for germination.

Smudges.—A farmer cannot materially control atmospheric temperatures, but in orchards that are in blossom in early spring when frosts are forming he is able to protect the blossoms in several ways, chiefly by producing smudges of smoke that will cloak the trees and prevent injury. So-called orchard heaters are little metal stoves usually burning oil. These are used to produce air currents and smoke in orchards and gardens, which prevent frost injury.

Soil temperatures are greatly controlled by tillage and good

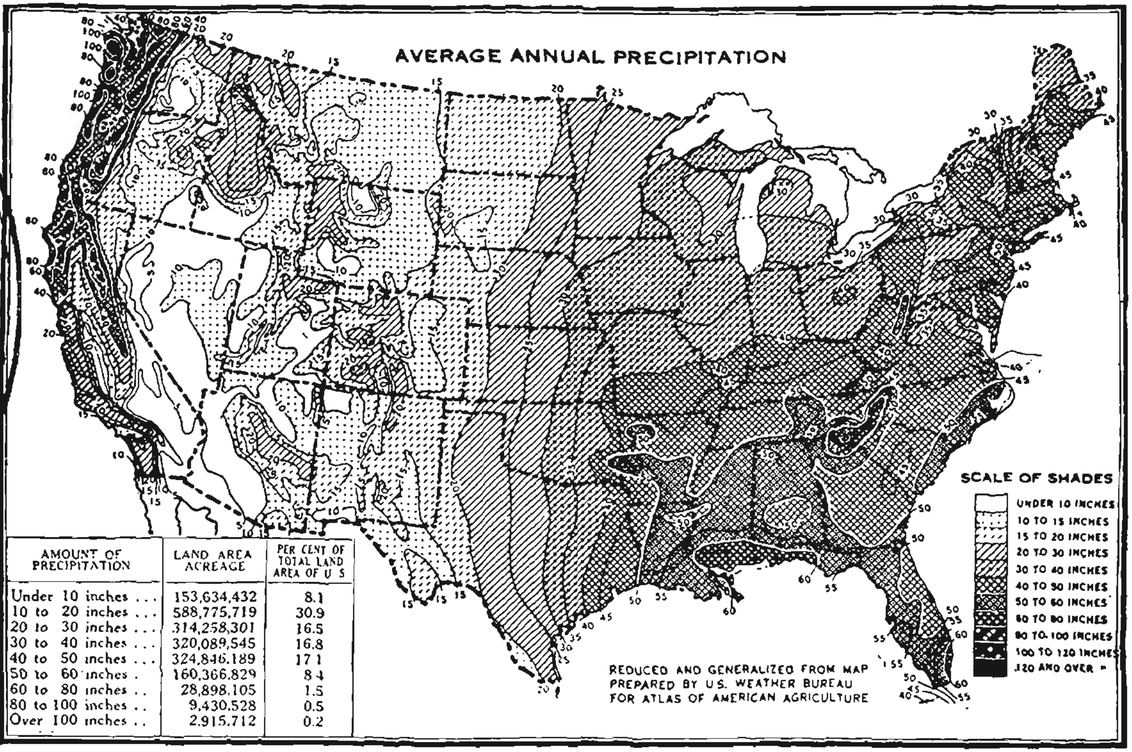
management. Early spring soils are readily warmed by harrowing the surface and allowing soil water to percolate downward. This in turn draws warm air into the soils. Thus the farmer is able to warm the seed bed materially. By the use of mulch as straw, leaves, corn stalks and other materials, man controls both extremes of soil temperature. When Irish potatoes, for example, are mulched with such materials the tubers are developed in cool, moist soil much better than if the soil were allowed to become too hot. Winter freezing and thawing of roots of perennial vegetables and fruits is greatly modified by mulches placed over them in the fall.

II. Soil Moisture.—Farm, garden and orchard crops require moisture in moderate quantities. Too much water will drown the roots and kill the plants and too little moisture will cause suffering for want of plant food. Moisture is used by the plant chiefly to carry plant food in solution into the roots through the tissues. There are *three forms of soil water:* (1) Free or gravitational water; (2) capillary or thick-film moisture; (3) fine-film or hygroscopic moisture.

With the exception of rice and a few others, our crops require *capillary moisture* only. Soils must be supplied with an abundance of this form of moisture for *the most rapid growth* of crops. Free water which stands in soils should be drained to depths low enough to avoid injuring the roots. This form of water in the lower soil layers will readily supply capillary moisture to the upper soil layers by capillary movement similar to that found in lamp wicks.

Hygroscopic or fine-film moisture is that which is found in the drier soil as in road dust on a hot day. We call such soils dry, yet they contain a little moisture. If a test tube containing a little of such dust be heated in a flame, moisture will be driven out of it and collect upon the cool glass near the top of the tube in visible droplets. Such fine moisture in soils may be useful to the plant in preventing death when weather is extremely dry. Growth cannot continue unless more moisture is supplied.

Moisture Control.—The farmer can greatly control the condition of moisture in soils by proper tillage and management: (Fig. 11) (1) Deep plowing will allow rain water to penetrate to greater depths. (Fig. 12.) (2) Breaking soil crusts by harrowing shortly after heavy, beating rains will allow free water to penetrate deeper. (3) The same treatment will also form a dust mulch which breaks the capillary contact and may reduce evaporation, except perhaps under the Western Plains conditions. (Fig. 13.) Continued harrowing during hot, dry weather theoretically con-



AMOUNT OF PRECIPITATION	LAND AREA ACREAGE	PER CENT OF TOTAL LAND AREA OF U. S.
Under 10 inches . . .	153,634,432	8.1
10 to 20 inches . . .	588,775,719	30.9
20 to 30 inches . . .	314,258,301	16.5
30 to 40 inches . . .	320,089,545	16.8
40 to 50 inches . . .	324,846,189	17.1
50 to 60 inches .	160,366,829	8.4
60 to 80 inches . .	28,898,105	1.5
80 to 100 inches . .	9,430,528	0.5
Over 100 inches . .	2,915,712	0.2

FIG. 11.—Average annual precipitation, including rain, snow, sleet, and hail. It shows a basis for agricultural divisions. (U. S. D. A.)

32458

serves capillary moisture. (5) By the use of straw and other similar mulches evaporation from the surface is greatly retarded. (6)

FIG. 12.—Moisture is conserved by fall plowing. Compare the growth on left, plowed in fall, with that on right, plowed in spring. (U. S. D. A.)

By the use of underdrains the free water table or surface is lowered and roots feed through greater depths where moisture is in capillary condition. (7) Where conditions are favorable for installing

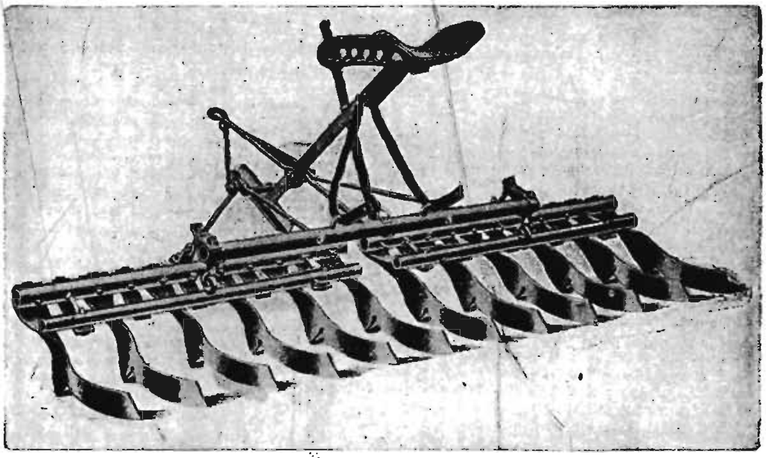


FIG. 13.—Moisture is conserved by pulverizing the surface and crushing the clods. An Acme harrow is good for this.

irrigation systems farmers are able to supply water when needed for the growth of their crops. Irrigation is managed so that the water will change to capillary form as fast as supplied to the soil. (8) In dry-farming regions packers, as cultipackers and rough rollers, are good to hasten the capillary rise of water from the

lower soil layers to the seed beds or roots. In all such cases the farmer maintains the soil mulch to prevent surface evaporation.

III. Plant Food.—Our crops take about one-twentieth or five per cent of their food supply from the soils in which they grow.

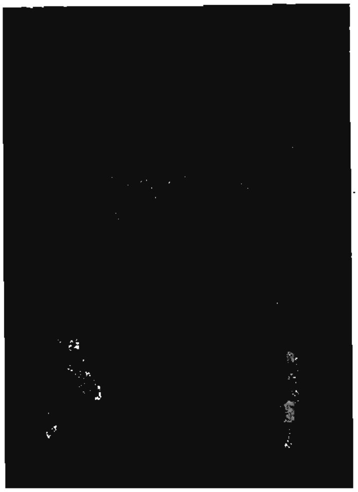


FIG. 14.—Root hairs shown on roots of germinating oats. (Montgomery's Productive Farm Crops.)

This plant food is all taken up by root hairs (Fig. 14) in the liquid form by being first dissolved in soil moisture. The solution is absorbed through the tissues by a process called osmosis. (Fig. 15.) Surplus water is given off by the leaves, called transpiration. (Fig. 16.)

The other nineteen-twentieths or 95 per cent of the plant food of our crops comes from the atmosphere. It is chiefly taken in through the pores of the leaves and other tender surfaces. (Fig. 17.) It consists chiefly of carbon dioxide from which all plants bearing green leaves are able to make starch. We are all

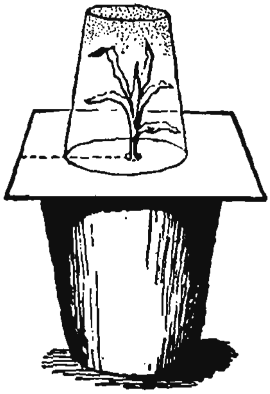


FIG. 15.—The lower membrane of the egg is exposed to water in the bottle. The two liquids tend to exchange places through the membrane, but the water moves faster and soon fills the egg to overflowing. It then rises in the glass tube above.

FIG. 16.—A potted plant with glass inverted over it will show moisture given off by the leaves.

familiar with the fact that carbon and its compounds make up almost the entire tissue of dry plants such as wood, corn stalks,

hay and grains. If a bundle of perfectly dry hay or other crop be weighed and then burned, and the ashes weighed, this point will be demonstrated. The amount of wood placed in the stove to burn is great compared with the ashes removed therefrom. Most of the burned material corresponds to that which the plant has taken during growth from the air. Starch ($C_6H_{10}O_5$), sugar and cellulose constitute the bulk of this.

Important Soil Elements.—Plants take from the soil ten or twelve different chemical elements. Most of these are in great enough abundance in all soils to amply supply the needs of plants. These few, however, may need *replenishing* by the grower—nitrogen, phosphate, potassium, and calcium. Plants readily take up *nitrogen* in the form of nitrates so the farmer supplies materials

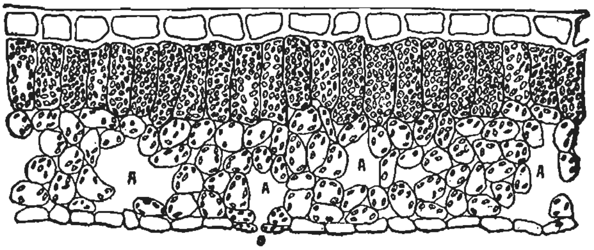


FIG. 17.—Cross-section of green leaf under the microscope, showing air spaces (A), breathing pore at S, epidermal (skin) cells at top and bottom, palisade cells below the upper skin, and the loose cells just below these. Chlorophyll grains are seen in all but the epidermis

which contain nitrogenous compounds that will readily change to nitrate form. All nitrates are soluble in soil moisture and can then be absorbed by the plant.

Phosphorus is usually supplied in some form of phosphate called "phosphoric acid." It may have considerable available phosphorus for the plant to use. It is composed of phosphorus with oxygen and with calcium or other mineral.

Rock phosphate, mined in Tennessee and elsewhere, is ground very fine and applied to soils because of its content of phosphorus. It becomes available only when there is a good supply of organic matter in the soil.

Potassium is applied to soils chiefly in four forms; muriate of potash and sulfate of potash, which are each 48 to 50 per cent potassium oxide (K_2O); *kainit* is a crude product as taken from European mines. It contains about 12 per cent of potassium oxide. Wood ashes from hard woods contain as much as 3 to 10 per cent of potassium oxide.

Calcium in the form of lime is usually supplied in one of

three forms. *Crushed limestone* ($CaCO_3$) acts rather slowly and lasts for several years. *Freshly burned lime* or calcium oxide is very active, neutralizing acid in soils rapidly and lasts for a much shorter time. *Hydrated lime* is composed of burned lime which has become partially air slacked and has taken up moisture. Its action is similar to fresh lime, but its use is less economical because of its weight and price.

Barnyard manures and green manures supply the chief lacking ingredients for soil. These become available as decay proceeds. Different kinds of barnyard manure, when well cared for, vary in composition chiefly with the kinds of animals producing them: Poultry, sheep, horses, swine, cattle. The value of manure also depends on the age of animals; the kind and amount of feed; the litter used and the care of the manure.

Green manure varies in value with the kinds of plants producing it. Legumes are best. They gather nitrogen from the soil air and store it in their tissues and when the crops are turned under the nitrogen and other ingredients gradually become available for other crops.

IV. Need of Oxygen.—All soils which are not water-logged contain air, about one-fifth of which is oxygen. Many experiments have shown that when oxygen is lacking for any reason, our crop plants suffer or die. Botanists have shown that the leaves of plants breathe oxygen as do animals, in addition to taking up carbon dioxide and transpiring moisture. (Fig. 16.) The leaves of plants turn yellow if the roots are in water-logged soil. This may be observed in wet seasons by noticing plants on the wettest spots of a field.

V. Sunlight is needed for all plants bearing green coloring matter called chlorophyll, in their leaves or branches. It is in the presence of sunlight only that chlorophyll-bearing plants are able to produce starch and sugar from carbon dioxide and water. This process is called photosynthesis.

$$6CO_2 + 5H_2O = C_6H_{10}O_5 + 12\,O$$

Carbon dioxide + Water = Starch + Oxygen

The work of manufacturing starch in the presence of sunlight is one of the chief functions of leaves. (Fig. 17.) The transpiration of water through the breathing pores is a second important function. Green leaves cannot continue to live and function unless sunlight is present. This is readily demonstrated by placing leaves in a dark place, as by placing a board over grass for a few days.

The leaves soon lose their color and die. It would be proper to say that 95 per cent of the plant food of our crops is dependent upon sunlight and air.

VI. Freedom from Enemies.—Crops must, of course, be protected from injurious insects, from many plant diseases, and from other natural enemies. The most serious enemies of each of the crops are discussed in the crop chapters.

Parts of the Plant

So far as use is concerned, our common crop plants may be considered as being composed of roots, stems, leaves, flowers and seeds.

Uses of Roots.—Roots are chiefly for the purpose of supplying plant food to the tissues of plants from the soils in which they grow. A secondary purpose is to support and anchor plants in place. Brace roots seen near the base of corn stalks and other plants help to support them. Aërial roots often found on such stems as ivy and poison oak aid in attaching the stems to surfaces upon which they climb.

Root systems vary greatly. Some crops as alfalfa, clover and the nut trees have deep tap roots with few fibrous roots. Others have fleshy roots which furnish food for man, as beets, carrots and sweet potatoes. Fibrous-rooted crops such as corn, true grasses, strawberries and others feed near the surface and are more susceptible to drouth than deep, tap-rooted plants.

Root hairs are composed of fine plush-like growth on the surface of young fibrous roots. (Fig. 14.) Their surfaces added together are much greater than the roots themselves. The purpose of root hairs is the absorption of moisture and plant food from soils. Osmotic action takes place chiefly through root hairs.

In transplanting plants from hotbeds to gardens it is important that roots be not injured and that root hairs be protected from drying.

Uses of Stems.—The chief purpose of the plant in the growth of stems is to support leaves and flowers where air and light are available. Underground stems are also useful to plants in multiplying them and in storing food. Man makes use of many of the stems for fodder or other kinds of feed for livestock or as food for man. Stems of plants and stems of leaves vary greatly in length, size and form. These are so familiar to the student that they need not be discussed here.

Functions of Leaves.—Several functions of leaves have already been enumerated. (1) To serve as foliage receiving gases

from the air; (2) receiving sunlight and warmth; (3) bearing chlorophyll; (4) manufacture of raw products such as starch called photosynthesis; (5) the taking in of carbon dioxide to be used in these compounds; (6) the transpiration or breathing out of surplus water vapor (Fig. 16); (7) the breathing of atmosphere in and out similar to animals, particularly in the dark.

Function of Flowers.—In most of our agricultural crops flowers are naturally formed for the purpose of seed production. A typical perfect flower has two kinds of essential organs (Figs. 18 and 19): Stamens to produce pollen and pistils to receive the pollen and produce seeds. In some flowers only one pistil and several stamens are found as in plum and peach. In other cases many pistils are found as in strawberries and blackberries. Besides many examples of perfect flowers we also find certain crop plants producing imperfect flowers, *i.e.*, flowers with only stamens or pistils. On the corn plant, for example, the staminate flowers are borne in the tassel and the pistillate flowers are found in the ear. Pollen is scattered from the tassels of corn plants by the wind. When a pollen grain lies upon the sticky stigma surface near the end of a silk a long fibrous growth ensues which penetrates the entire length of the silk reaching to the ovary where the kernel is to be formed. There is one silk for each kernel. When mature corn is found with kernels lacking there has been some difficulty in pollinating. Hot, dry winds at silking time often injure silks or destroy pollen, resulting in a poor crop of corn.

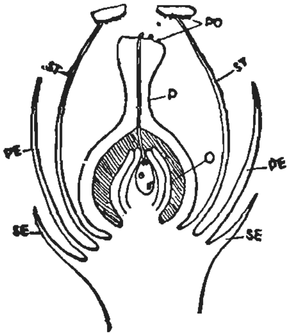


FIG. 18.—Diagram of cross section of a flower P, Pistil; O, ovary with young seed or egg cell receiving the pollen growth; ST, stamens; PO, pollen scattering from stamen to pistil; SE, sepals.

Self-pollination.—Oats, wheat and barley are chiefly self-pollinated, that is, the pollen from flowers will grow upon the stigmas of pistils of the same flowers. When self-pollination takes place in plants the seeds are more likely to produce plants like the parent plant. Many fruits and other crops that bear perfect flowers and are capable of pollinating often fail to produce fruits and seeds. This is true chiefly among plants that have been cultivated as apples and pears. Pollen in the flowers seems to be sterile upon pistils in these flowers. Varieties which will not pollinate themselves are called self-sterile varieties. To produce crops of fruit other varieties must be grown near them which blossom at the same time.

Cross-pollination is found in rye, corn (Fig. 19), a number of grasses, most legumes, fruits and vegetables. Plants grown from seeds produced by cross-pollination are likely to vary considerably from their parents. Plant breeders take advantage of the power of plants to cross-pollinate for the production of new varieties.

Nature seems to prevent self-pollination in a number of ways even with perfect flowers. Some natural devices for this purpose are found: (1) The stamens in upright flowers may be too short to supply pollen to the pistil; (2) in drooping flowers the stamens may be so long as to scatter their pollen away from the pistil; (3) the stigma of the pistil matures earlier than the stamens and receives pollen from other flowers; (4) the stigma is not ready to receive pollen until after the stamens of that flower have shed their pollen; (5) some underground buds never open but produce seeds within.

Wind-pollination.—The characteristics of flowers which are polliuated by the wind differ greatly from others. The chief characteristics are given: Light, dry pollen grains; flowers without nectar; no fragrance; no showy color.

Fig. 19.—Each silk of corn leads to its embryo or ovule. A grain of pollen falling on the end of the silk sends a growth the entire length to the ovule. Then the kernel may begin to develop. In this case only a few kernels were so fertilized. (U. S. D. A.)

Insect-pollination is found *chiefly in flowers having some* or all of the following characteristics: Heavy, sticky pollen, nectar, fragrance, showy colors.

Seed Formation.—The purpose of most flowers is solely to

produce seeds. After pollination takes place and the growth from the pollen grains reaches the egg cells (ovules) in the ovary, seed development takes place. Most fruits will not form unless pollination takes place. The growth of the seed is very rapid. The surrounding fruit is for the purpose of inducing animals and other agencies to carry the seeds to other places.

Storage matter in seeds is formed to nourish the plant at germination time. Man takes advantage of this storage of nourishment and uses the seeds of wheat, beans, etc., for human food and to feed livestock.

Saving Good Seeds.—Seeds produced by garden and field crops vary greatly in size, plumpness and other qualities. It pays the gardener and farmer to select seeds from the best plants in order that subsequent crops may be improved. Wholesale selection by seedsmen is not usually conducive to crop improvement. Attention to characteristics of individual plants will aid greatly in selecting the best seeds. Mark plants from which seeds are desired by tying a strip of white cloth to those you consider best. These are characteristics in crops for which to watch: (1) Immunity from disease; (2) best flavor of product; (3) proportion of edible parts as in tomato or watermelon; (4) trueness to type or variety characteristics; (5) earliness of maturity; (6) habit of plant; (7) yields. After seeds are selected many of them require sorting by means of sieves and fans.

Each kind should be properly labelled and stored for planting the next season. Keep them in a dry place and free from weevils and mice. Small lots may be kept in open vessels covered with wire screen. Place this in a dry attic rather than in a damp cellar.

Many seeds become infested in the garden or field with the eggs of weevils and grain moths. To be certain that these do not multiply while the seeds are stored, treat the seeds with carbon bisulfid. A teaspoonful in each cubic foot of air-tight space is sufficient. For large lots of seed use a pint to 500 cubic feet. Cover the bin tightly during the treatment. Keep away matches and flames, as the material is very explosive.

Age of Seeds.—When old lots of seeds are sold by dealers they are sometimes treated with sulfur fumes to bleach them. Old seeds may be detected by loss of luster, dullness of color, odors of sulfur or bleaching materials, and by testing for germination.

Old seeds are always less likely to grow than fresh ones. Some kinds, as those containing oil, deteriorate very rapidly with age. Others may live a little longer, but freshness should be insisted

upon when purchasing seeds. Most seeds will retain life longer when stored in very dry places.

Impurities in seeds may usually be detected quickly by use of a small lens. Dip your wet finger in a lot of small seeds and look at them carefully with a pocket lens. Never be guilty of planting weed seeds. Insist upon clean lots, true to variety and free from dirt and weeds. (Fig. 20.)

When buying seeds by sample insist that the order be filled like the sample. Laws in many states require that many of our common seeds be sold only after they have been analyzed by the dealer or by state laboratories. A guarantee of quality then goes with the seeds. This protects the buyer from being imposed upon by careless or unscrupulous dealers.

Seed testing is easily conducted by using such methods as are described in the corn chapter.

The Plant and the Seasons.—In temperate zones most of our economic plants have adapted themselves to certain moisture conditions (Fig. 21), and to changes of seasons.

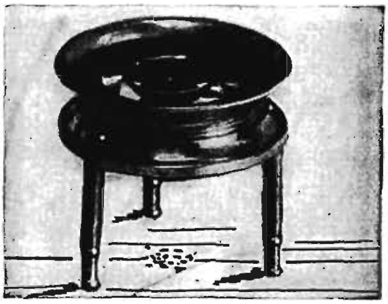


FIG. 20.—A lens should be used to examine seeds for impurities before purchasing.

All the annual plants produce seeds to remain over winter and grow the next year, but the most interesting and marked effects of seasons are found in woody plants such as orchard trees. Perennial plants of all kinds form buds and some means of protection of these buds. Among the forms of protective cover we find bud scales, waxy or downy growth, lenticel or corky growth on the leaf-scars and breathing pores of twigs.

In late summer and early fall while leaves are on trees and *shrubs, buds are found* in the angles of the leaves. These buds have begun to put on their winter coats in anticipation of the coming winter. A little later you will find the leaves will snap off readily because of the formation of a natural separation from their twigs. In other words, the leaves do not break off because of frost but actually grow off by the formation of a corky layer which separates them from the twigs. Examine twigs in late fall or winter to see the leaf-scars and corky growth. The green color of twigs has disappeared and the scattered breathing-pores are plainly seen now because of being filled with corky growth.

If tillage crops are grown between the trees avoid those which

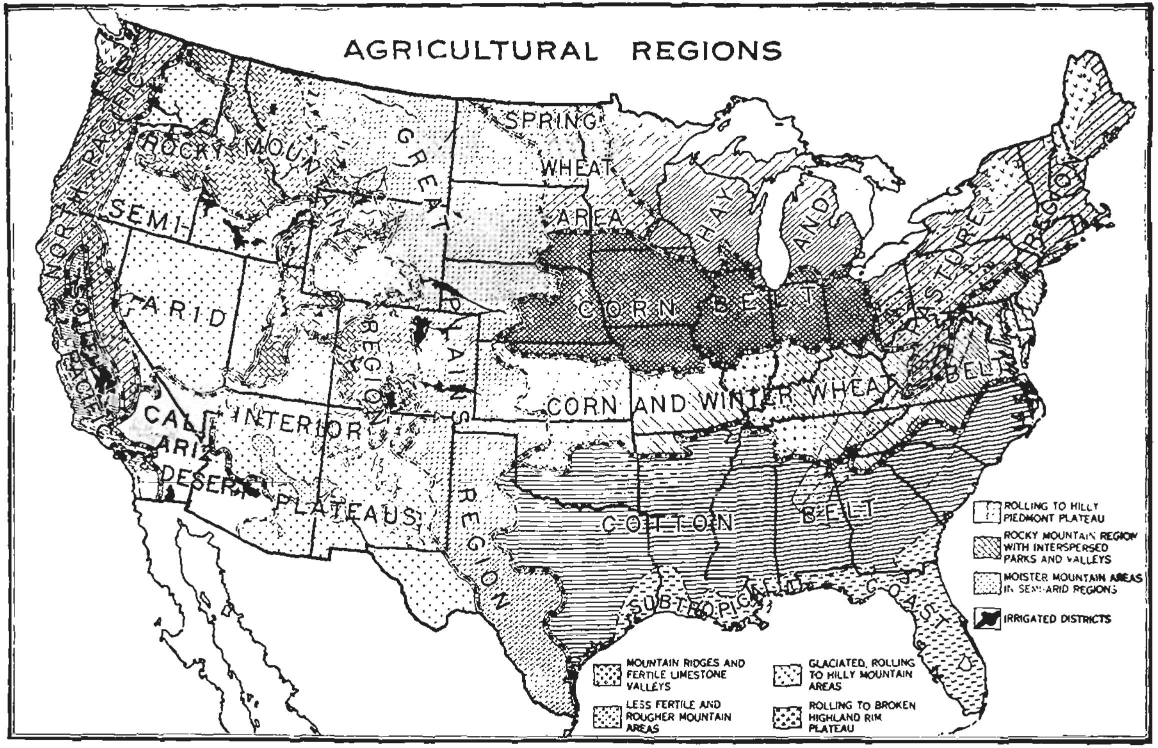


FIG. 21.—Agricultural regions. East of the Great Plains region the climate is humid; west of this line the climate is arid or semi-arid except in the North Pacific region and in the higher altitutes of the mountains. (U. S. D. A.)

make little growth or which require late tillage of the orchard. This is particularly important in regions where winters are apt to injure fruit buds. It is a good plan to sow winter cover crops in orchards in late summer. This growth will tend to dry the soil and check the growth of trees at the time in the fall when trees should be naturally preparing for winter.

Storage of plant food in woody plants is not so plainly seen as in seeds, but it always takes place and in remarkable amounts. Twigs, stems, trunks and roots are filled with elaborated food in the form of starch and similar products. The flow of rich juices from maple trees from which syrup is produced is one good evidence of this.

FIELD AND LABORATORY EXERCISES

1. **Osmosis.**—Plants secure their soluble food from soils through the root hairs and fibrous roots by a process called osmosis. This is a natural process occurring from cell to cell and from tissue to tissue in all parts of animals and plants. Osmotic action may be well demonstrated by an experiment with an egg. (Fig. 15.)

Select an egg about two weeks old, shown by the large air cavity at the large end of the egg. Remove some shell at this end the size of a dime, without injuring the tough membrane holding the egg liquids. Now at the pointed end make a hole the size of a knitting needle through the egg and membrane. Place over this small hole a glass tube of any length available. Seal it in place by use of melted paraffin, sealing wax, or chewing gum. Be sure that it does not leak around the base of the tube. Now set the large end of the egg over a wide-mouthed bottle filled with water so that the water will touch the membrane of the egg. In a few hours liquid from the egg will be found to rise in the tube, showing that water has passed through the membrane from the bottle and forced the contents of the egg upward. Replenish the water in the bottle as needed. You may attach more glass tubing by connecting pieces with rubber tubing. Support the tube with a clamp and laboratory stand to avoid too much pressure upon the egg. Sometimes the egg membrane is strong enough to support a column of liquid in the tube many inches high. Before the membrane is broken test the water in the bottle for albumen by adding a few drops of silver nitrate. A cloudy appearance proves the presence of albumen. Where did it come from? Have both liquids passed through the membrane?

Osmosis may be defined as an exchange of two liquids through a membrane separating them. The greater movement is always toward the denser liquid, but there is some movement in both directions.

2. **Root Hairs.**—In a glass containing a little water place a blotter so that it will lie against the glass. Water rises and keeps the blotter wet so long as you supply enough water in the glass. Place between the blotter and the glass, seeds of several kinds, such as oats (Fig. 14), wheat, corn and beans. Keep in a warm place and after growth begins note the fine plush-like growth on the small roots. Examine these with a hand lens where the light is good. Estimate, if you can, how many times the surface of a root is multiplied by the development of root hairs.

This experiment may be varied by placing wet sand in a bottle, placing seeds near the top and wrapping the bottle with black paper to exclude the light. Roots will easily be seen inside the glass, abundantly supplied with root hairs.

3. **Transpiration from Leaves.**—Arrange a potted plant with a cardboard over the surface and a glass inverted over the top as shown in Figure 16. A little later note the accumulation of moisture in the glass due to the transpiration of moisture from the leaves. Why do leaves give off moisture? What would happen to a plant if it continued to take up moisture from the roots in securing its food and no water were given off by the plant?

4. **Need of Sunlight.**—Invert a box or lay a wide board over some grass. After several days notice the change in color of the grass leaves. Why is cauliflower bleached when the outside leaves are tied over the head? Explain why celery is bleached when banked with soil. Why do weeds not grow under straw mulches? Why are weeds killed when soil is thrown over them during cultivation?

5. **Leaves Seek Light.**—Put a box of oxalis or other house plant in a window and note the length of time required for the leaves to turn toward the light. Now turn it around and try again. Explain.

6. **Mineral Matter in Plant Tissue.**—It has been stated that mineral elements taken from the soil through the roots are very small fractions of the plant's composition. Dry some corn stalks in the hot sun or, better, in an oven. Weigh these after thoroughly dry. Now place them on a shovel in a fire until all the organic matter is burned away and nothing is left but the ashes. Weigh the ashes and carefully estimate the fraction of the original weight of the dry matter. What does this ash represent?

7. **Air and Germination.**—Place some beans, peas, corn or other seeds in a bottle of water. At the same time arrange others as suggested in No. 12 where the air will not be entirely excluded by water. Put both lots in a warm place and compare results from time to time. Do any of the seeds under water actually grow or do they merely swell? What does the experiment prove?

8. **Roots Need Air.**—In two cans or pots grow such plants as peas or beans. After the seedlings are a few inches high plunge one of the pots in a vessel of water and allow it to remain immersed to the top of the soil for a few days. Does growth in this pot continue as in the other? What seems to be the effect when soil air is excluded by too much water? What lesson regarding soil drainage does the experiment teach?

9. **Moisture and Germination.**—Soak one lot of seeds including melon seeds, peas, beans, corn, carrots or others that are handy. After one day plant these in one end of a box of soil and in the other end plant the same number and kinds that have not been soaked. After a few days note the differences in germination.

In a box of sand plant several kinds of seeds, packing them well to bring the soil moisture to them promptly. In the other end plant the same number and kinds, but leave the soil loose. Note any differences in rapidity of germination.

10. **In a cold soil** where the temperature is not over fifty, plant seeds of several cool-weather crops as oats, radishes, and peas. Plant also at the same time seeds of hot-weather crops such as melons, beans, corn, and okra. Note the difference in rapidity of growth in the cold soil.

11. **Importance of Large Seeds.**—In a box or pots of soil plant large and small seeds of the same kinds and compare results in time of germination, thriftiness of growth, and if possible continue the observation for several weeks. Use radish, corn, beans, and wheat. Keep all conditions alike.

12. **Testing Seeds.**—Test twenty-five or more seeds of several kinds in a box of soil, in wet blotters, in wet cloths or in other conditions favorable for their growth. Determine percentages of germination for each lot.

13. **Seed Analysis.**—Get samples of small seeds of several kinds such as clover, timothy, alfalfa, and the small grains. Place one lot at a time

on a sheet of white paper and by counting (Fig. 20) determine the approximate or exact number of seeds present. Now with a wet pencil point and the use of a lens remove all weed seeds into a separate pile. Also remove light, chaffy seeds, grit or other inert matter. Determine the percentages of each of these that were present in the original sample.

14. **Storage Matter in Seeds.**—*Test for starch with iodine in cross*-sections of corn kernels. Examine for oil in seeds of cotton, flax, turnip, or peanut. In soaked seeds of beans, peas, and corn remove the germ or compare its size with the storage matter in the other parts of the seed.

15. **Parts of a Flower.**—Examine blossoms of orchard fruits or other plants that are available. Locate and study the stamens and pistils. If corn is in tassel and silk use that plant also.

Questions and Investigations

1. Mention the essential conditions for plant growth.
2. Why may barley and oats be planted in early spring while melons wait until early summer?
3. Explain the moisture terms: Gravitational, capillary, hygroscopic. Of what use is each form?
4. Enumerate ways by which the farmer may control soil moisture.
5. Give the main sources of plant food for our crop plants.
6. Name the most important soil elements.
7. Discuss the relation of sunlight to plant growth.
8. What are the uses of plant roots? Of root hairs?
9. Discuss functions of leaves? Define photosynthesis and transpiration.
10. What is chlorophyll? From what is starch made?
11. Discuss the uses of flowers.
12. Compare self-pollination with cross-pollination.
13. Mention three flowers which you think are wind-pollinated; three insect-pollinated. Why?
14. Describe pollination and seed formation in corn.
15. Why do seeds store nourishment? Why does man use this?
16. Give characteristics of plants from which to save seeds.
17. Discuss seed analysis and impurities.
18. Define annuals, biennials, perennials.
19. How do perennial woody plants prepare for winter?
20. Define osmosis accurately. Where in your body is it going on? Where in plants?

References.—U. S. Farmers' Bulletins: 1390, Market garden and vegetable seeds; 434, 676, Seed production; 948, Rag-doll tester; 1232, Seed marketing.

Farm Mechanics.—Make seed containers and racks for holding them, at school and at home; seed drying rack; seed storage bins; seed pedigree record holder; smudge pots.

Calculations.—1. A young farmer was selecting a farm for purchase. Besides considering all outward characters, he examined the soil for nematodes by looking at the roots of such plants as soybeans, carrots, lettuce, etc. By choosing a farm of 80 acres, free from these parasites instead of one generally infested, how much a year does he save during the first 8 years if the presence of nematodes would reduce crop yields 25 per cent? He considers his labor income will be $2,100 a year, ⅔ of which is from crop production.

2. Farmer Wise always treats seeds with semesan, corrosive sublimate, or formaldehyde before planting and inoculates legume seeds with proper soil bacteria. The labor income from crops is as stated in problem 1, and yields are increased 33 per cent by the treatments. Calculate the profit if the cost for labor and material is $7 a year.

CHAPTER III

PROJECTS IN SOIL MANAGEMENT AND IMPROVEMENT

ALL soils must be managed well to maintain them in good condition. A large proportion of all farm soils need improvement. In many cases nature is gradually making soils poor. This is particularly true in hilly sections. In a smaller proportion of cases natural environments gradually improve soils. This is noticed in low, flat lands where rich soil materials and plant food are washed from higher lands. Soil regions are shown in Figure 22.

Soil Maintenance.—Every farmer should strive to prevent his soil from becoming poor. The following are the main points for consideration (Fig. 23): (1) The growth of winter cover crops. (2) Contouring and terracing the surfaces of hillsides and slopes. (3) The annual return of as much plant food as the crops remove. (4) Maintenance of organic matter or of humus as by green manuring where practicable. As these four methods are also used in the improvement of soils they are discussed in this chapter.

Soil Improvement Projects.—Students should practise soil building. Projects may be planned in improving old fields, in rebuilding soils depleted by long cropping, or in upbuilding soils which were naturally poor. Very notable examples of success in such endeavors are to be found in all states. Very productive soils have been developed from poor ones and are now producing good yields of crops while all farms around them are still poor. The financial benefit resulting from the renewing of old fields, or other types of soil building may be measured in increased crop yields. As in the case of improvement and beautification projects (Chap. XIX), the profits from such efforts may be determined by valuations made by disinterested parties at the beginning and at the end of the project. Soil improvement projects usually last for a series of years, but crop production may continue, and usually should continue while the soil improvement is in progress.

The essential points to be used in planning an improvement project are those which will (a) improve the physical condition; (b) its chemical composition and food yielding power; (c) its moisture holding power; (d) its germ life or bacteria.

From the standpoint of farm operations these may be used under the following heads: (1) Tillage such as deep plowing of

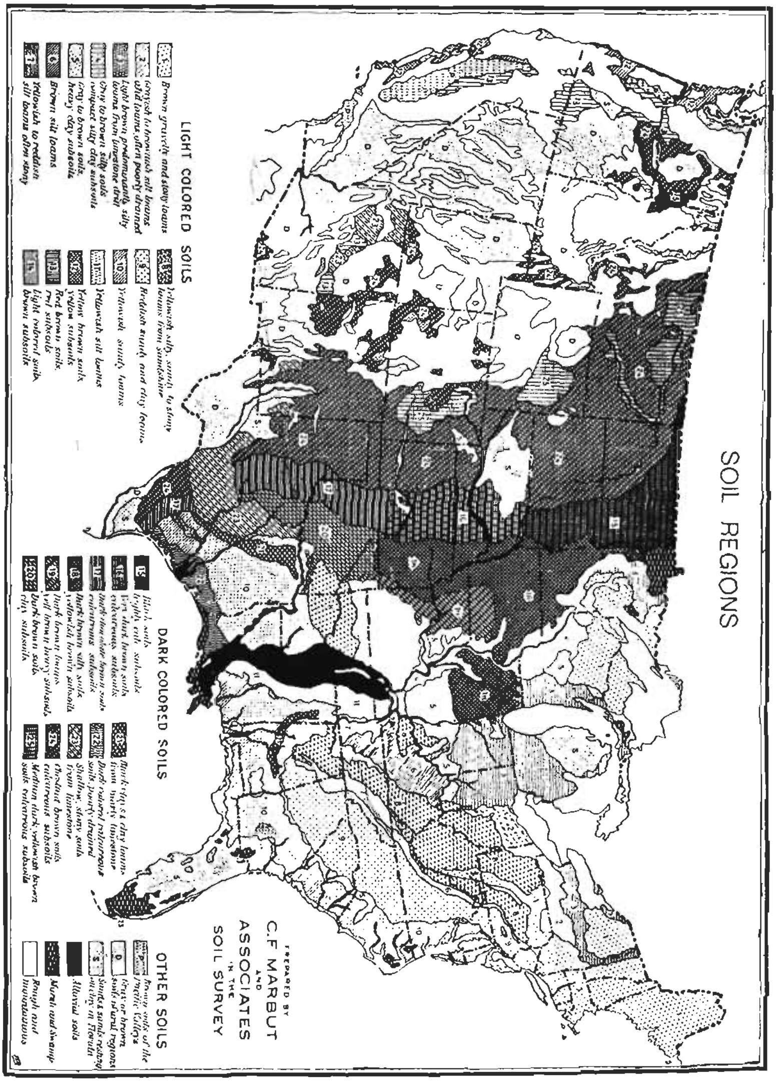


Fig. 22.—Regions of different types of soil. (U. S. D. A.)

the subsoil. (2) Drainage. (3) Irrigation. (4) Liming. (5) Use of commercial fertilizer. (6) Applications of barnyard manure and the growth of livestock on the farm. (7) Growing cover crops. (8) Turning under green manure. (9) Use of bare-fallow. (10) Dry farming methods. (11) Inoculation of seeds and soil. (12) Terracing and contouring. (13) Use of soil amendments as in alkali regions.

I. Tillage.—Some soils are non-productive because of poor tillage. The use of farm tractors is encouraging farmers to plow

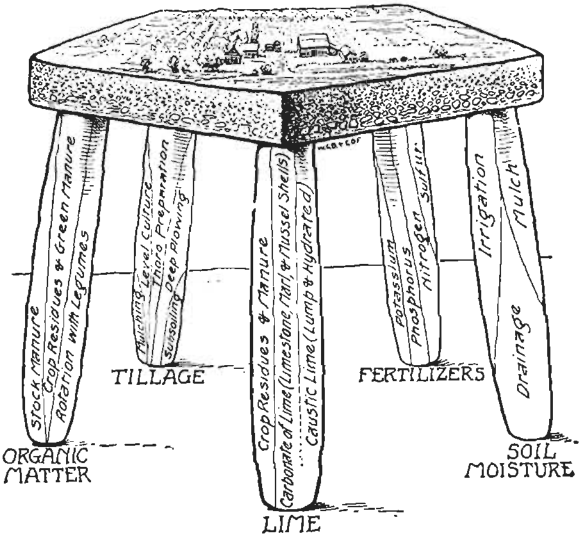


FIG. 23.—Fundamental factors in the maintenance or improvement of the crop-producing capacity of soil. (Cornell Reading Course. Lesson 148.)

deeper. Each time the soil is plowed the depth should be increased until a very deep surface soil is the result. A sudden increase in depth may give bad results if the lower soil be very poor. Suit the form of moldboard to the purpose. (Fig. 24.) Where subsoils are very tough or hard the use of a subsoil plow which stirs the bottom of the furrow without throwing bad soil on top should be practised.

Never use a subsoil plow if the subsoil is open and porous. When the physical condition of the soil is poor, rotation should be planned by which more frequent plowing will result.

Disk plows mix the under soils more with the surface layers

than ordinary turning plows. For this reason deep tillage machines use disks. Soils may be deepened more quickly by their use.

Surface tillage with disk harrows (Fig. 25), pulverizers (Fig.

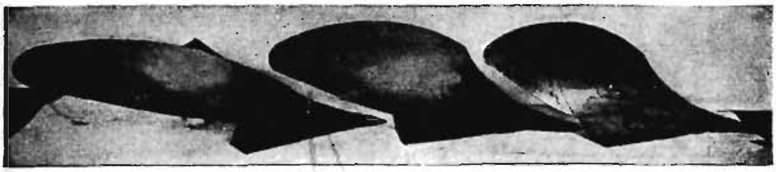


Fig. 24.—Three types of moldboards of turning plows. Left to right: sod, general purpose, stubble. (Mosier and Gustafson, Soil Physics and Management.)

26) and cultivators plays an important part in improving crop yields.

II. Drainage.—Ditches and underdrains are for one or more of the following purposes: (a) To remove surplus water; (b) to admit air to soil and roots; (c) to deepen feeding areas for roots

Fig. 25.—A disk harrow may be set to stir a plowed field to nearly half the diameter of the disks. (I. H. Co.)

(Fig. 27); (d) to reduce suffering at time of drouth; (e) to aid tillage; (f) to increase chemical action; (g) to warm the soil.

Drainage is needed on such places as the following: (1) Flat lands which are too wet because of overflow of streams at time of heavy floods. (2) Bogs or marshes holding free water near the surface too much of the time. (3) Large flat areas or depres-

sions having clay subsoils. (4) Depressions in hillsides which hold water coming from the land above as by seepage. (5) Fields which are to be flooded at certain times for such special crops as rice or cranberries. (6) Alkali lands under irrigation.

Underdrains are better than open ditches for these reasons:

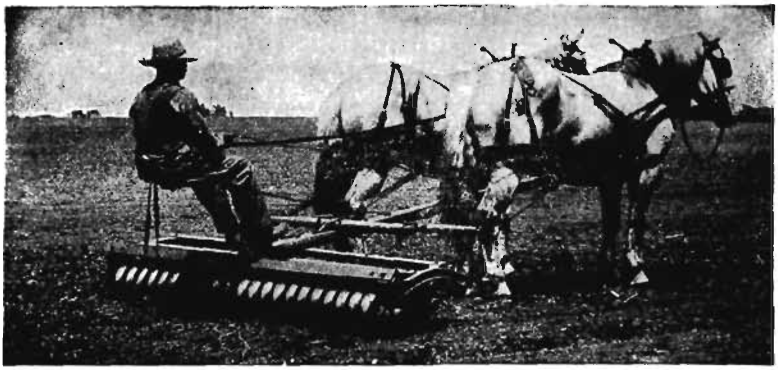


FIG. 26.—A roller with corrugated surface, called culti-packer. The ridges of soil formed soon crumble and produce a surface mulch. (Mosier and Gustafson, Soil Physics and Management.)

The whole surface may be used for crops. It is more convenient to move machinery from one part of the field to another. There

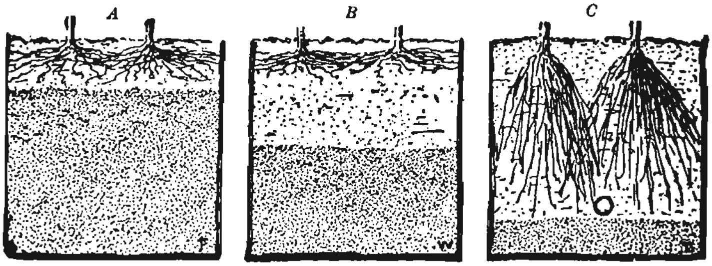


FIG. 27.—Drains cause plant roots to feed deeper. A, water just under roots in wet weather: B, water far below roots during drouth; C, roots and water as deep as the tile drain.

is no waste growth there. Drains are more permanent.

III. Irrigation.—In dry sections of our country, growers realize the great importance of irrigation. In humid regions, however, the benefits of irrigation are less understood. The use of overhead pipes to supply water to gardens and truck crops is very profitable in dry seasons. Irrigation water is sometimes obtained by pumping from wells in beds of submerged streams.

In western arid regions the great irrigation systems impound

water in large reservoirs usually in the beds of streams from which water is conducted through more or less permanent canals and ditches or through pipes to individual farms. Coöperative enterprises are found in many regions, each member holding a certain number of water shares, which give him limited irrigation privileges.

Water is supplied to orchards and fields usually in one or two ways: (1) By flooding where the whole area is to be covered; (2) by furrows, the water flowing down furrows until they are saturated and then being diverted to other farms in succession; (3) by modifications of these plans.

IV. Liming.—The application of lime to soils has the follow-

FIG. 28.—Effects of lime on yields of clover. Left not limed. Right limed with rock dust at the rate of two tons per acre. (Cornell Reading Course, Lesson 148.)

ing effects (Fig. 28): (1) Sour or acid soils are made neutral. (2) Organic matter such as green manure rots more quickly. (3) Plant foods in soils are liberated for growing crops. (4) Conditions for bacteria growth in the soil are improved. (5) Light, sandy soils are made more compact and hold moisture better. (6) Heavy clay soils are made more porous for the penetration of roots and air. (7) Lime is supplied as a direct plant food for alfalfa and other members of the clover family.

Application of Lime.—Liming should be done after plowing. Never plow under lime as it goes downward too fast. In rotations lime should be applied before the sowing of the crops that need it most. For example, in a four-year rotation of corn, wheat, clover, and timothy, lime should be used when the soil is prepared for

wheat, as the clover is sown in the wheat and will immediately begin to make use of the lime.

The rate of application may vary from one-half ton to two, three or more tons per acre.. Truog (Fig. 29) and potassium paracyanide tests indicate how much lime to apply. The litmus paper test will indicate which soils are sour. The frequency of application and the kind of lime will also govern the amount used.

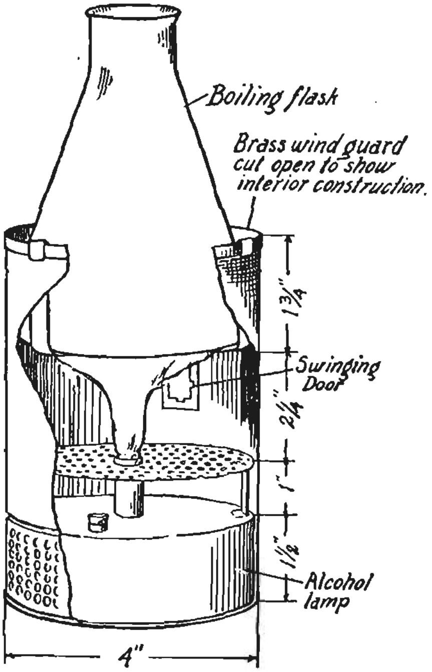


FIG. 29.—The heater and flask of Truog test outfit. The heater is made of brass and was devised especially for making the test on the farm. (Wisconsin Station.)

Kinds of Lime to Use.—Different forms of lime vary in their strength or amounts of calcium present. If burned lime be applied, small applications made more frequently are better than heavy applications several years apart. Ground rock is less likely to be injurious, is slower in action, and may be applied in larger quantities and less frequently than burned lime.

V. Use of Commercial Fertilizer.—In Chapter I. nitrogen, phosphoric acid and potash were mentioned as the chief forms of commercial fertilizers. Nitrogen may be purchased in a number of forms. The most quickly available of these are nitrate of soda (15 per cent N) and sulfate of ammonia (20 per cent N). Less available commercial forms are dry blood (6 to 10 per cent), (tankage, 6 to 10 per cent), cottonseed meal (4 to 6 per cent). Nitrogenous fertilizers stimulate leaf growth and improve the color and health of foliage. When much nitrogen is used, foliage is green later in the fall, fruit ripens later and is more susceptible to disease. Stems are larger but weaker.

Phosphoric acid is chiefly in the form of acid phosphate (14 to 18 per cent P_2O_5). Ground rock phosphate is about twice as rich in phosphorus, but it is much less available to plants. Bone

meal may contain 28 per cent. Thomas slag, a by-product from steel furnaces, averages about 18 per cent and is much prized by apple growers. It may vary greatly in composition.

The use of phosphoric acid stimulates growth of roots and stems, improves quality of fruits and seeds, hastens ripening, and increases resistance to disease.

Potash in one of four forms, muriate of potash, sulfate of potash, kainit, or wood ashes, is applied to soils to stimulate vigor

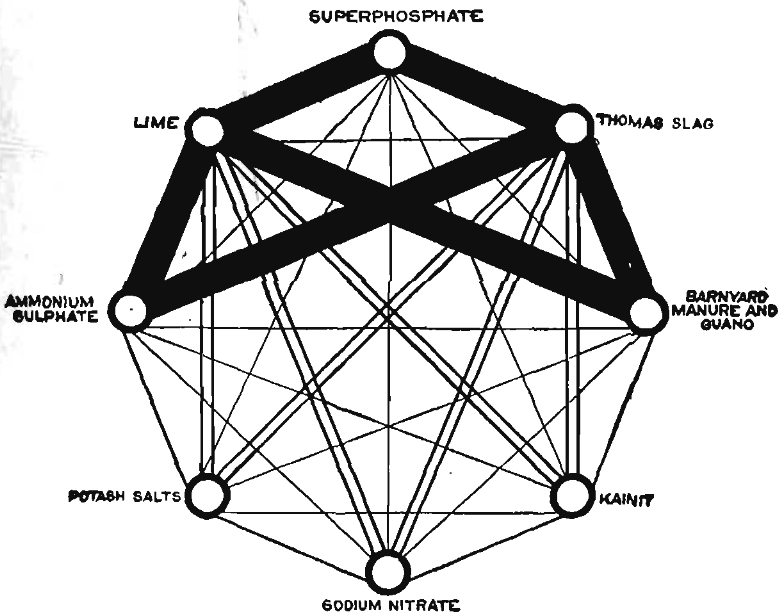


FIG. 30.—Fertilizers joined by single light lines may well be mixed before they are applied. Those joined by double lines are best when applied separately. Ingredients joined by black bands should not be mixed. (U. S. D. A.)

and seed and fruit production. It balances the effect of nitrogen and increases resistance to diseases. Crops producing starch as potatoes, corn and wheat require potash. The special forms to use for different crops are noted in the discussions of those crops.

Home Mixing of Fertilizers.—The most progressive farmers often mix their own commercial fertilizers. (Fig. 30.) It saves the purchase of ingredients which are not needed, mixtures can be made to suit the soil and crops better, the cost is less, and fillers need not be handled. Fillers are materials of little or no value mixed with fertilizers, chiefly for the purpose of making the mate-

rial sell for a low price per ton. For an example of home mixing see Index.

VI. Livestock in Relation to Permanent Agriculture.— Permanent agriculture is made much simpler and easier by the use of livestock in the farming system, for the following reasons: (1) Better rotations of crops are likely to be practised as a variety of crops are grown. (2) Farm wastes of many kinds are turned into soil fertilizers and financial gains. (3) Crops that would otherwise be taken to market are consumed on the farm and their plant-food ingredients are returned to the fields. (4) The chief products sold from the farm are in more concentrated form, containing much less plant food. (5) Commercial feeds purchased to supplement farm feeds contain much fertilizer to be added to the farm soils.

FIG. 31.—A manure spreader makes the best use of the manure, saves labor, and produces the most uniform crop.

(6) Stalks, straw, and other materials used as bedding for livestock are added to the soils in the manure supplying organic matter and humus. (7) Farm labor is used to better advantage.

Barnyard manure is such a valuable product on the farm that it should be used as economically as possible. (a) Probably the best way to use barnyard manure is to frequently remove it directly from stables to the fields to be turned under by the next plowing. Soils are good absorbents of liquid manures and when spread on fields while fresh, little plant food is lost.

(b) Another plan is to store manure where it is formed, under cover or in sheds, where livestock may tramp it down firmly and where rains cannot leach through it. Under such conditions it keeps well. At a suitable time it is taken directly to the fields and spread evenly. (Fig. 31.)

(c) Still another plan which is more expensive is to provide a special manure shed with a concrete basin in the bottom to hold the liquids. This shed receives daily all the manure produced,

the liquid being absorbed by the litter. From here the manure is spread upon the fields from time to time.

(d) Probably the worst plan for handling barnyard manure is to throw it out under the eaves of the barn, allow it to leach for

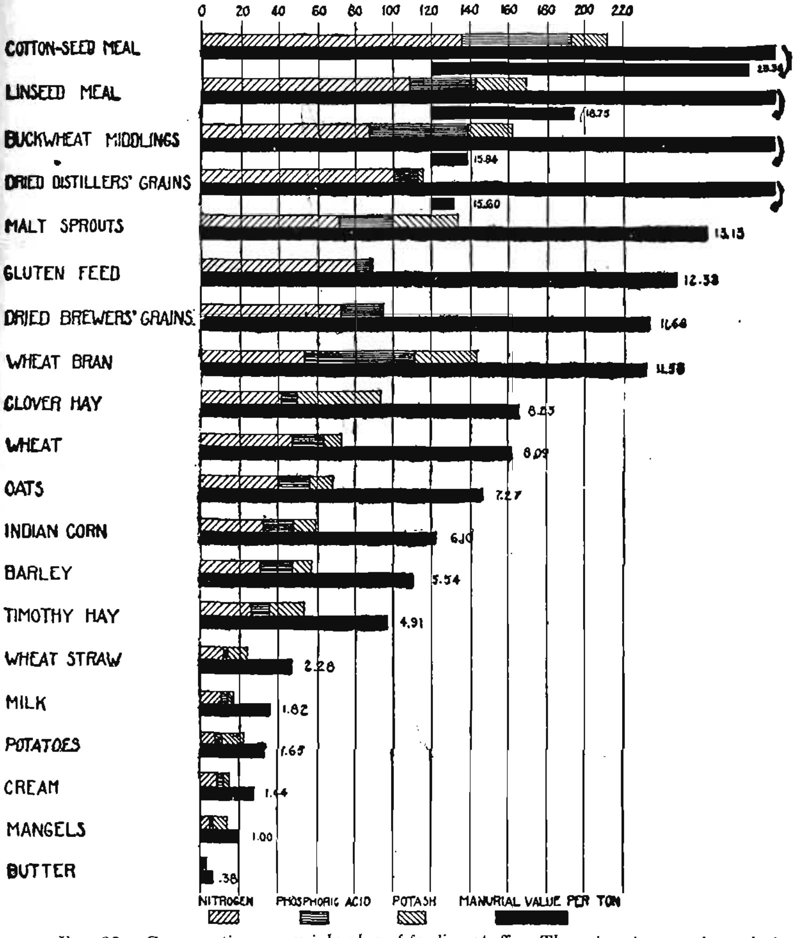


FIG. 32.—Comparative manurial value of feeding stuffs. The price given at the end of each black bar is for one ton of the feed when nitrogen is 15 cents, phosphoric acid, 4 cents, and potash, 4 cents per pound. (Wall's Productive Feeding.)

several months, then take it to the fields and put it in piles and finally spread it. In spite of the great losses, this plan is often followed by some thoughtless farmers.

All feeds consumed on the farm furnish plant food constituents for other crops. (Fig. 32.)

The accompanying table shows the composition of barnyard manure from different sources and the relative values of these manures based on prices of commercial fertilizer ingredients when the basic prices per pound are, nitrogen twenty cents, phosphoric acid five cents, potash six cents.

Average Composition of Barnyard Manures.

Fresh barnyard manures	Pounds per thousand			Value per year 1000 lbs. live weight.	Value per ton of manure
	Nitrogen	Total phosphoric acid	Potash		
Cow manure	3.4	1.6	4.0	$39.00	$2.00
Horse manure	5.8	2.8	5.3	42.00	3.24
Sheep manure	8.3	2.3	6.7	46.00	4.35
Hog manure	4.5	1.9	6.0	80.00	2.06
Hen droppings	16.3	15.4	8.5		9.48
Mixed stable manure	5.0	2.6	6.3		3.02

VII. Growing cover crops during the winter is one of the best means of maintaining and rebuilding soils. In climates where snows do not cover the soil throughout the winter, cover crops will make considerable growth during a part of the year when the fields would otherwise be idle. The best times to start cover crops are in late summer or early fall after the other crops are harvested. or to plant them between the rows of those crops.

Among the benefits derived from the growth of winter cover crops are the following: (1) Leaching of available plant food is checked. (2) Washing of surface soils during the wet seasons is largely prevented. (3) Blowing by wind of surface soil is somewhat checked. (4) If legumes are chosen for cover crops, they may gather nitrogen from the air. (5) Roots of these crops unlock plant food from soils and hold it in a form more readily available for future crops.

Among the best crops for winter covers are rye or other small grains. With the grain should be mixed some legume, winter vetch in northern regions, crimson clover in central regions, and burr clover in South Atlantic and Gulf states are useful. In alfalfa regions this crop serves the purpose admirably, and plowing to rotate the field should not be done until spring, perhaps after the first cutting of alfalfa hay.

VIII. Green manuring is a natural adjunct to the growing of winter cover crops. Too often, however, the farmer is tempted

to cut the crop for hay, or other purpose, instead of plowing it under as green manure. He should remember that plowing under the crop saves spreading barnyard manure and also saves harvesting the crop itself. Aside from these two arguments the following benefits of green manure are given: (1) Organic matter is added to soils in the best form. (2) The decay of this organic matter forms the necessary supply of humus for soils. (3) Food brought from greater depths by the roots is deposited just under the surface for the next crop. (4) The quick decay of the green crop renders plant food available for the next growing crop. (5) Decay of green matters stimulates chemical action in the soil. (6) A more rapid multiplication of helpful soil bacteria results.

Growing Green Manures.—The farmer must plan ahead to have green manure crops ready to turn under at suitable times.

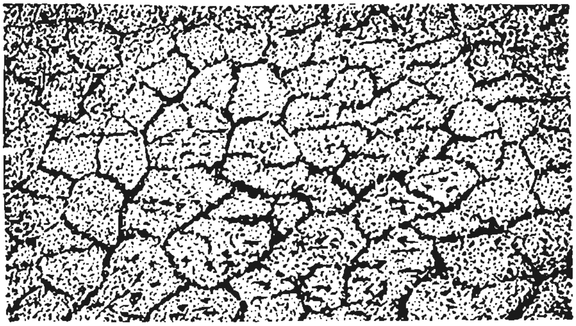


Fig. 33.—Frequent cultivation will avoid such cracking of soils.

His plans are often frustrated by drouths, severe winters, diseases and insect enemies. A mixture of crops will usually succeed better than single crops. Frequently green manure crops may be grown in the summer between other main crops; such as a growth of early cowpeas after harvest. Sods from grasses and clovers make splendid green manure. The farmer should strive to have a legume of some kind in the crop mixture because of the nitrogen-gathering power of this family of plants. When green manures are grown during the fall and winter to be plowed under the next spring, he should always sow the seeds early enough to produce as much fall growth as possible. This will save waiting for spring growth to turn under. Long delays in the spring may seriously affect the crops which follow.

In turning under green manures he should avoid having too heavy growth, or if the growth is heavy and somewhat mature it should be thoroughly incorporated with the soil by disking before

or after plowing. This will greatly hasten its decay and will not retard the capillary rise of soil moisture to the growing crop which follows.

IX. Use of bare-fallow methods will greatly increase crop production. Experiments have shown that soils out of condition for long periods of time are less productive. If their surfaces be baked and cracked (Fig. 33), if clods are allowed to form, if they remain dry too long, or if they are puddled with water, conditions become unfavorable; plant food may change to unavailable forms,

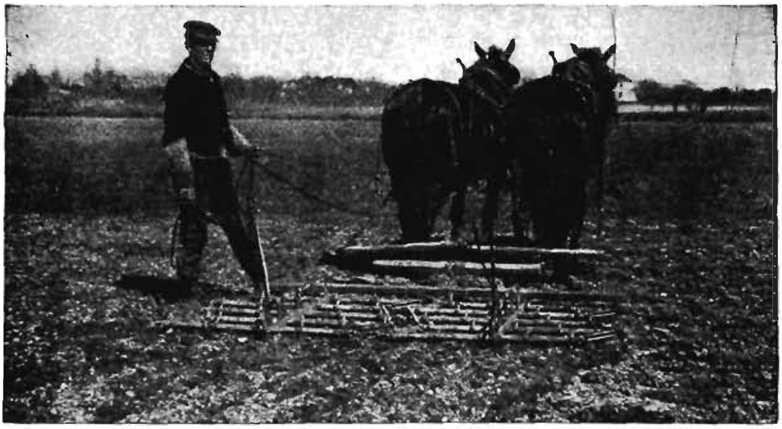


Fig. 34.—A spike-tooth harrow is used in the final preparation of the seed bed, in covering seeds, in killing small weeds in such fields as young corn and cotton. (New Jersey Station.)

decay and other helpful chemical changes are retarded, and bacterial growth is stopped or seriously checked.

Before the planting of spring crops such as potatoes, corn, sorghum, cotton, tobacco, sugar beets, and gardens, plans should be made to maintain a bare-fallow for a period of three to six weeks. When late summer crops, as alfalfa, timothy, clover, late potatoes and small grains, are to be planted, the bare-fallow period may precede those as well. This is done by plowing the ground as many weeks before planting as possible. The ground should be harrowed (Fig. 34) the day it is plowed to prevent loss of moisture and clodding of soil. This is particularly important when soils are very wet or very dry. Re-harrowing the soil shortly after each heavy rain is advisable.

Several effects of bare-fallow methods are given: (1) Surplus moisture is allowed to penetrate to greater depths. (2) Surface evaporation may be checked. (Fig. 35.) (3) Warm air is

allowed to enter the soil and benefit the bacteria, hasten chemical action, liberate plant food, and warm the beds for seeds to be sown. (4) Weed seeds in the soil are sprouted and the sprouts killed by subsequent harrowings. (5) The under soil becomes well settled and capillary movement of moisture toward the seed bed is improved. (Fig. 36.) (6) The surface is left in better condition for sowing seeds. (7) Germination will be more prompt and more uniform, and a better stand and growth of the crop will result.

X. Dry-farming methods are applicable both in arid regions and where there is an abundance of rainfall. Seriously dry sum-

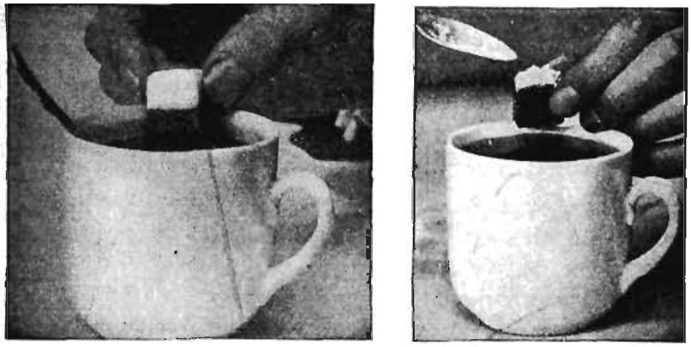


FIG. 35.—Liquid rises quickly in a lump of sugar, as it does in packed soil. Liquid does not escape through a loose mulch on top. (*Dunham Co., Berea, Ohio.*)

mers occur in all the states, and dry-farming methods may be profitably employed as well as in the drier regions. The following are the chief elements in soil management which constitute dry-farming methods: (1) Maintenance of bare-fallow before seeding, as already described. (2) Extra deep plowing to produce a deep water reservoir. (3) Subsurface packing (Fig. 26) which consists in the use of heavy rough rollers; these firm the lower layers of soil and leave the top loose. This tends to induce upward movement of moisture. (4) The careful and persistent maintenance of a dust mulch over the surface, by means of cultivation, to prevent weeds. (5) The use of winter cover crops and the ridging of soils in the fall to prevent the soil from being blown away by the wind. (6) The selection of crops which will endure drouth, such as grain sorghums, millets and alfalfa. (7) Growing crop plants farther apart than is customary in moist climates.

XI. Inoculation of Seeds and Soil with Helpful Bacteria.—The power of plants of the legume family to enter into partnership with certain kinds of soil bacterias is taken advantage of by

farmers when they inoculate legume seeds with such bacteria or inoculate the soils where these crops are to grow. Many soils are naturally provided with the necessary bacteria and when conditions are made favorable for their growth, as by the use of lime, green manure, and barnyard manure, these bacteria multiply rapidly and no artificial inoculation may be necessary.

When legumes are naturally or artificially inoculated with the suitable bacteria, they find homes for themselves in nodules formed upon the roots of these plants. (Figs. 37 and 38.) In return for this hospitality the bacteria supply the plant with nitrogen which they have obtained from the soil air. This nitrogen is used by the plant during its growth mainly for protein compounds which are formed in all the tissues, roots, stems, leaves and seeds. We are already familiar with the fact that members of the clover and pea family are richly supplied with nitrogenous material suitable for human use and for livestock. Beans and peas, for example, are often eaten as meat substitutes. This real partnership existing between the bacteria and legume host is one of the best examples of what is called *symbiosis.* Whenever two organisms are found to exist together for mutual benefit, this name is applied to the relationship. Do you think of similar examples of symbiosis found in nature?

FIG. 36.—Moisture rises quickly where soil is packed by a foot print or roller. This will aid in germination of seeds, but the surface mulch should be reëstablished with a rake or harrow. (Dunham Co., Berea, Ohio.)

Experiments have shown that beneficial soil bacteria of many kinds aid in crop growth, aside from the symbiosis just described. When composts and manures are applied to soils millions of bacteria are introduced which will result in the liberation of plant food for crop growth. Gardeners and farmers do well to make soil conditions favorable for the multiplication of bacteria.

XII. Terracing is very commonly practised by farmers in some regions (Fig. 39), while in other hilly sections where terracing is fully as important, farmers seem to have learned nothing of its benefits. With the use of a carpenter's level or other simple

device, lines are run around the slopes of hills. These lines may be level or slightly sloping from one end to the other. If they be indicated by frequent stakes, ridges of soil may be formed along the lines which will be the beginning of terrace formation. This first step in the terracing may be termed a *contour line* or *contour ridge,* so-called from the fact that each line follows a level around the curves of the hill. Terracing machines may be used to move plowed soil toward the terrace lines. (*Fig.* 40.)

The benefits from contour lines and terracing are apparent. (1) Washing of the soil is prevented from becoming rapid because it is interrupted at short intervals by the ridges. (Fig. 39.) (2) Soluble plant food which would otherwise be carried off is retained for crop growth. (3) Damage of lower fields by flooding with water and soil deposits is prevented. (4) Soil moisture which will be needed later by the growing crop is stored in the soil.

FIG. 37.—Nodules on the roots of legumes are the homes of helpful bacteria. When digging to find nodules, avoid stripping them off by pulling. Rinse the roots in water (see page 149).

XIII. Soil Amendments.—In many large areas, particularly in semi-arid regions, alkali deposits seriously interfere with crop production. For example, in black alkali soils of the West, sodium carbonate is usually the injurious matter present. This is soluble in soil moisture and may be taken up by plants in quantities so large as to injure or prevent their growth. Where irrigation is practised, underdrains are laid to carry away the alkali material taken from the upper soil by irrigation water. Where irrigation and underdrainage are impossible, certain soil amendments are used. If land plaster or sulphate of lime, made from gypsum, be applied to such fields a chemical action takes place which renders the sodium compound insoluble and reduces the injury to crops.

Field and Laboratory Exercises, Trips and Projects

1. Select several exercises from soil laboratory manuals mentioned under "References" to demonstrate the following phenomena in the laboratory: Percolation, capillarity, differences in porosity between light and heavy soils, water-holding power of soils, flocculation of soils by liming and clodding of soils by puddling.

2. Try experiments to contrast differences in loss of moisture between soils that are manured and those that are packed on the surface.

3. Try experiments with packed and pulverized sugar (Fig. 35) described in texts as *School and Home Gardening* and in *Productive Plant* Husbandry.

4. If a Truog soil tester is available in the agricultural room or

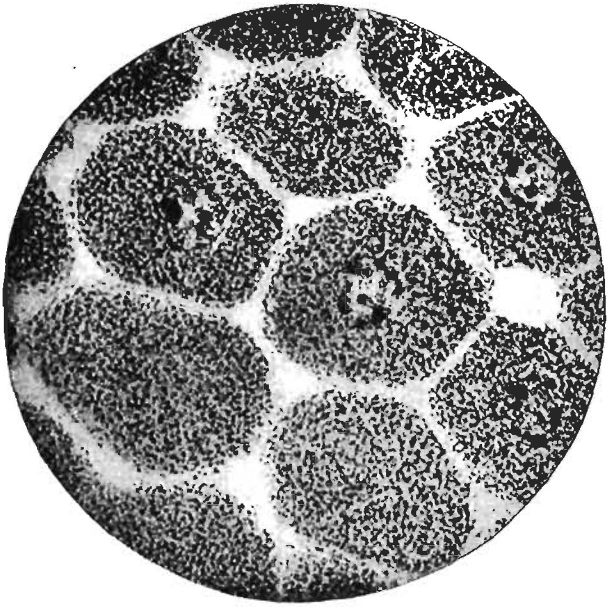


FIG. 38.—A few cells from a cross-section of a legume nodule, highly magnified, showing bacteria inhabitants of nodule. (U. S. D. A.)

chemical department, use it in testing soils from different fields of several farms. Test these soils also with litmus paper. Demonstrate the alkalinity of wood ashes and lime of various forms by the use of litmus paper.

FIG. 39.—Soil washing prevented by terraces. (U. S. D. A.)

5. Buy commercial fertilizers and practise mixing suitable types on a smooth floor. Calculate formulas of the mixtures. (Consult Index.)

6. Practise inoculation of legume seeds by one or two methods.

Field Trips.—Visit farms where terraces or contours are being made. Participate in the levelling and other work.

Visit fields where bare-fallow is being maintained in preparation for seeding. Note the effects of various operations upon the soil and moisture.

Study cover crops during the season of growth on fields and note as many of their effects as possible.

Dig and carefully rinse the soil from legume roots and search for nodules.

Examine fields while green manures are being turned under. Study the effects of disking before or after the plowing.

Where soils are being plowed with turning plows, disk plows, and where subsoil plows are being used, measure the depths and study efficiency in pulverizing and crumbling of soil particles.

With the use of field levels, carpenter levels, or other levelling devices, run lines to determine possibilities of drainage of certain areas that would

Fig. 40.—Running terracing machines. Showing students how. (E. R. Thompson, Okla.)

be benefited by drainage. Calculate depths of ditches; the cost of digging, purchase of tile, of laying and covering tile.

Soil Improvement Projects.—Select a field of several acres which needs improvement in various ways. Check over the list of thirteen methods of soil improvement given on the third page of this chapter. Determine which of these may be most profitably used in rebuilding the soil of this particular field. Plan all details for a project in improving this field. Outline the studies corresponding to each of the steps to be undertaken and give references for each of the study topics.

Certain other trials may accompany the project operations. (Fig. 41.) Each of the steps toward improvement may be compared with other adjoining lands not so treated, or, if necessary, with strips reserved for checking the results of certain operations such as liming, deep tillage, green manuring, etc.

Questions and Investigations

1. Give the chief points in soil maintenance.
2. In what four ways may poor soils need improving?
3. Mention thirteen operations involved in soil improvement.

4. Discuss tillage with reference to soil improvement.
5. Compare open ditches with underdrains.
6. Give the effects of drainage on soils.
7. What kinds of places are likely to need drainage?
8. Describe different methods of irrigation.
9. Give a list of effects of liming.
10. What forms of lime are most easily secured in your region?
11. Mention several sources of commercial nitrogen; phosphoric acid; potash.
12. Discuss the relation of livestock to permanent agriculture.
13. Name the kinds of barnyard manure in order of greatest value per ton.
14. Describe good and bad methods of handling barnyard manure, preferably those you have seen.
15. Give a list of benefits derived from the growth of winter cover crops.
16. What is green manure? Give its benefits.
17. What is bare-fallow? Give benefits of a bare-fallow.
18. Enumerate the chief dry-farming methods.
19. Describe the relation of legume bacteria to their hosts. What is symbiosis?
20. Describe terracing, preferably that you have seen.

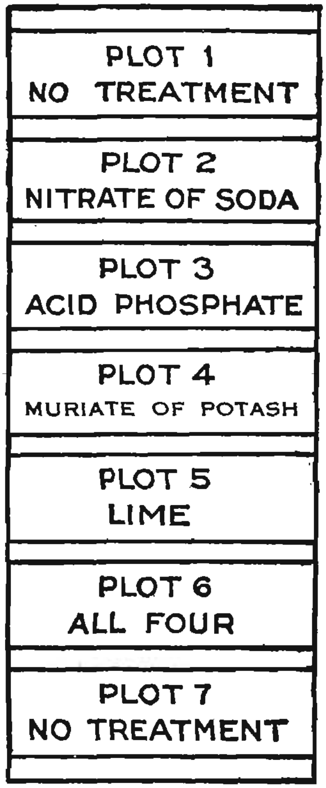


Fig. 41.—Trials with fertilizers, lime and different treatments may be conducted with crop projects. Such *trials may* be along one edge of the area.

References.—U. S. Farmers' Bulletins: 805, 815, 1131, 1606, Drainage; 1669, Terracing; 1526, Clearing land; 1234, Gullies; 446, Crops for alkali land; 924, 986, Increasing crop yields; 921, Liming; 978, Handling *manure*; *1520*, Soybeans; 1148, 1153, Cowpeas; 515, Vetches; 1143, Lespedeza; 1475, Crop rotations; 1545, Dry-farming; 1669, Terracing.

Farm Mechanics.—Make or repair leveling devices; terracing drag; lime spreader; fertilizer drill; soil testing case. Repair harrows; plows; manure spreader; *rough* roller.

Calculations.—1. A young farmer estimated that an average of ½ in. of his best soil washed away each year if left bare during the rainy winter. In 12 years the farm will be worth as little as \$25 per acre. At present it is worth \$100 per acre. What will be his loss per year from his 80-acre farm?

2. What would be the number of cu. yd. of soil lost from an acre each year? From the 80-acre farm in 12 years? (See problem 1.)

3. The young owner of the farm mentioned above terraced it at a cost of 90¢ per acre for his own labor and that of his team. What was his profit due to *terracing if it* stopped 95 per cent of the erosion?

CORN ENTERPRISE

Analysis into Jobs.—The important teaching units in the corn enterprises may be grouped under the following twenty-two jobs. References are to pages in *New Agriculture* and to numbers of *U. S. Farmers' Bulletins.* See *Field-Crop Enterprises,* and *Southern Field-Crop Enterprises.*

1. **Deciding whether or not to grow corn,** pp. 24, 25, 57; *Bulletins,* 773, 1149, 1236, 1634, 1679. *Problems for local inquiry.*—(*a*) What are the local yields of corn? (*b*) Ask farmers to compare growing corn for profit with other lines of farming.
2. **Choosing the type and the variety,** pp. 61–64, 68; *Bulletins,* 773, 1149, 1634, 1679. *Local inquiry.*—(*a*) List all varieties locally grown and the special purposes of each. (*b*) Compare them in yields of fodder and of ears.
3. **Choosing soil, field and acreage,** pp. 39, 57, 68; *Bulletins,* 773, 1475. *Local inquiry.*—(*a*) What are the best rotations with corn used in your region? (*b*) What types of local soils are best suited to corn? (*c*) What sizes of fields of corn do you find? (*d*) Why does the same farmer vary the acreage from year to year?
4. **Selection of corn in field for seed,** pp. 31, 32, 60, 74; *Bulletin* 1175. *Local problems.*—(*a*) What methods of procuring seed corn do you find? (*b*) Compare these methods. (*c*) Quote reasons given by farmers in defense of their methods.
5. **Curing and storing of seed corn,** pp. 60–62; *Bulletins,* 1175, 1260. *Local inquiry.*—(*a*) Describe local methods of storing seed corn. (*b*) Compare them as to results.
6. **Growing cover crop; providing organic matter,** pp. 28, 48, 49, 59, 68; *Bulletin* 1250. *Management problems.*—(*a*) What local rotations keep the best winter covers on the fields? (*b*) What special cover crops are sown locally? (*c*) Give time and rates of seeding. (*d*) What local practices best provide organic matter?
7. **Culling and judging ears for seed or for show,** pp. 64–66.
8. **Testing seed corn,** p. 66; *Bulletin* 948. *Local inquiry.*—What proportion of local growers use tested seed corn?
9. **Buying and mixing fertilizer,** pp. 27, 44, 45, 69, 70. *Local problems.*—How many farmers buy ready mixed fertilizers?
10. **Keeping records,** pp. 3, 18, 19; *Bulletins,* 511, 572, 782, 1182. *Local inquiry.*—Why do not more farmers keep farm records?
11. **Preparing soil for planting,** pp. 40, 41, 42, 50, 51, 59, 70; *Bulletins,* 773, 1149, 1307, 1537. Study local methods.
12. **Liming the field,** pp. 43, 44; *Bulletin* 921. To what extent is liming practiced in your region?
13. **Planting and fertilizing,** pp. 70–72, 210. Describe local methods of planting and fertilizing.
14. **Cross-harrowing corn,** pp. 50, 72, 73, 181, 211; *Bulletin* 660. Ask farmers why they do or do not practice cross-harrowing.
15. **Tilling between rows,** pp. 73–75, 182; *Bulletins,* 414, 660, 773, 1149.
16. **Controlling insects and diseases,** pp. 75–77; *Bulletins,* 739, 875, 891, 1025, 1029, 1124, 1260, 1307, 1397, 1483, 1498, 1548, 1562, 1595, 1651. Inquire and find what are the worst local enemies. How controlled?
17. **Making silage of corn,** pp. 78, 79; *Bulletin* 578. *Local study.*—How do farmers manage at silo-filling time? Find numbers of men and teams, work of each, time required, size of silo for each case.

18. **Harvesting with livestock**, pp. 72, 78, 341; *Bulletin* 1653. (*a*) How many local farmers use this method? (*b*) What livestock are thus fed? (*c*) Get opinions of farmers.
19. **Making fodder**, pp. 78, 79, 80; *Bulletin* 1511. *Local inquiry.*—(*a*) At what stage is corn cut for fodder? (*b*) Learn sizes of shocks. (*c*) Compare hand cutting with other methods. (*d*) How are shocks tied?
20. **Husking or gathering corn**, pp. 77–80; *Bulletins*, 1589, 1662. *Local inquiry.*—(*a*) Ask farmers to compare snapping with husking. (*b*) Ask them to compare gathering ears from standing stalks and from shocks.
21. **Storing corn**, p. 80. *Bulletin* 1483. *Local problems.*—(*a*) Learn sizes of temporary and permanent cribs; distances from barns. (*b*) Calculate bushel capacities of local cribs. (*c*) Compare these with sizes of fields.
22. **Grading and marketing corn**, p. 81; *Bulletins*, 1144, 1236, 1634, 1679. Ask farmers about their grades of corn; and about the best times to sell corn.

PRACTICES THAT REDUCE CASH COSTS
(Ill. Cir. 389)

1. Fit machinery to needs of farm.
2. Coöperate in owning expensive equipment.
3. Do custom work to reduce overhead cost.
4. Avoid an excess of power.
5. Repair machines at home in slack periods.
6. Feed horses according to work done.
7. Avoid an excess of labor.
8. Control costs of building, fencing, etc.
9. Test soil to save clover and alfalfa seed.
10. Grow legumes on adapted land.
11. Use home-produced food and feed.
12. Develop a farm and home budget.

CHAPTER IV

CORN ENTERPRISE

THE importance of corn growing as a project depends somewhat upon the soil and climate of the region. The world produces about four billion bushels of corn a year, and fully three-fourths of this is produced in North America. Other important corn-growing regions ranging next to the United States in importance are central Europe, Mexico, and Argentina.

Corn Regions of the United States.—The production of corn is one of the leading farm occupations throughout the corn belt which is shown in the darkest shading of the map in Figure 42. Through a series of years the leading corn-producing states might be given in the following order: Illinois, Iowa, Missouri, Nebraska, Indiana, Kansas, and Ohio. These seven states together produce nearly three-fifths of the corn crop of the United States. From the map it may be seen that corn is commercially grown in practically every state of the Union.

The growing of corn in the northern tier of states has been accomplished through selection of early-maturing ears until varieties have been established suited to the northern states and southern Canada. Varieties maturing in from sixty to seventy days from the time of germination are required in this section. In southern states, varieties requiring about one hundred and twenty days for maturity are sometimes grown.

Moisture Requirements for Corn.—It cannot be said that corn is suited for growth in dry regions unless irrigation is practised. This crop requires considerable rainfall during the growing season, as well as an abundance of moisture in the soil at time of planting. A study of the map shows that little corn is commercially grown in the drier states, and most of this is produced by irrigation. Where the annual rainfall is thirty inches or more, corn is found to be one of the important field crops. In the arid and semi-arid states some form of non-saccharine sorghum, such as kafir, is substituted. (Chap. VI.)

Selecting Soil for Corn.—The corn plant may be called a heavy feeder as it is a very heavy producer. The soil, therefore, should be very fertile. Heavy applications of green manure, barnyard manure, or commercial fertilizers are necessary to maintain

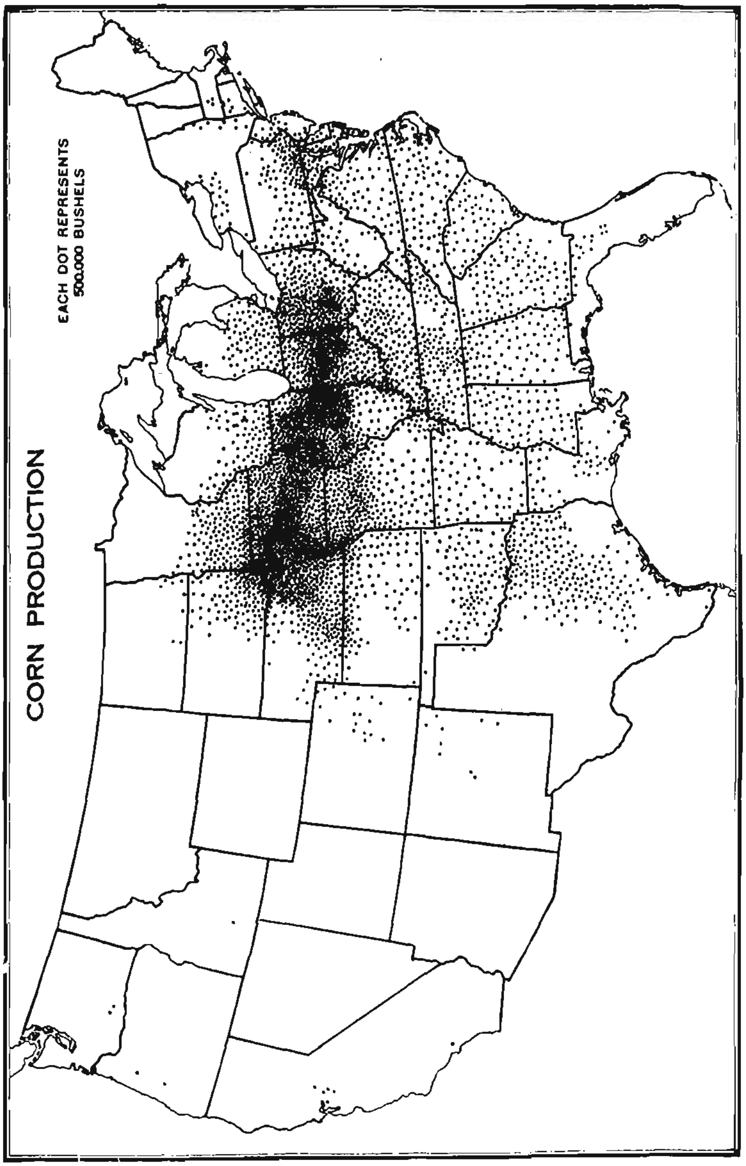


Fig. 42.—Distribution of corn. Each dot represents 500,000 bushels. (U. S. D. A.)

the fertility of corn soils. It should not only be rich, but should be well supplied with organic matter and should be well drained.

Select a field for corn where water does not stand more than a day or so at a time, even during the most rainy periods of the growing season. If possible select rich, black loam. Light, sandy soils are not well suited to corn growing. If it is necessary to use sandy soils, they should, if possible, be underlaid by clay subsoils.

FIG. 43.—In field selection of seed corn watch for healthy stalks as well as the best ears at proper height. (New Jersey Station.)

Preparation for Corn Growing.—A field where corn is to be grown the following year should be partially prepared the preceding fall. In the northern states fall plowing should be practised. The furrow slices may be left exposed to the winter weather and much benefit will result from freezing and thawing of the exposed soil.

In central and southern states it is best to sow a winter cover crop early enough in the fall to obtain an abundant growth before winter. The winter cover crop may consist of winter grains and winter legumes mixed together. Rye and winter vetch or rye alone will suit the central states. As far south as the Ohio river it is well to use the following mixture: One bushel of rye, one peck of crimson clover, and one-half peck of winter vetch, for each acre. Such a cover crop should supply an abundance of green manure when plowed under the following spring.

Winter cover crops may be sown without plowing the field, provided the crop already there is not too rank to be worked into the soil by the use of a disk harrow. Double disking is much less

expensive than plowing the field. If the soil is to be plowed the following spring the cost of plowing in the fall should be avoided if it is possible to start the cover crop well without it.

Fall Selection of Seed Corn.—One of the most important fall operations in preparing for a good corn crop is to select the best seed to be found in the region. Obtain permission from the owner of one of the best fields of corn in the neighborhood, then select the best ears from the best stalks and save them for the seed. The points given later for judging corn indicate the characteristics of good ears to save for seed. The best stalks from which to save seed corn are those which fulfil as many of the following points as possible (Fig. 43):

FIG. 44.—Racks for drying corn. Keep mice out of the room. Plenty of air must circulate about the ears.

1. Bear two or more good ears of corn.
2. Have the ears at suitable height from the ground, neither too high nor too low.
3. Have shanks or stems which allow the ears to hang down when ripe.
4. Have husks (shucks) which entirely cover the tips of the ears.
5. Have no sterile stalks near them.
6. Have ears that are ripe in due season.
7. Have no apparent diseases.
8. Those at the westerly side of the field where least pollinating with undesirable stalks is likely to be found.
9. Grown under normal conditions.

Saving Seed Corn.—Corn thus selected from the field in the fall will be far superior to any which can be purchased on the ordinary market and far better than any selected from the field or shock. It should be well kept through the winter for use in judging and testing during the winter and for planting the next spring.

There are several good ways of storing seed corn to keep it free from mold, from weevils, and from rats and mice. In northern states where weevils are not serious the husks should be removed as soon as the corn is gathered. Let it dry well by exposure to air and sun until the surplus moisture is gone. It may then be kept in a suitably dry place, as in a barn loft or in the attic of the house. Wires may be horizontally stretched between rafters and the corn may be laid on these wires as on a shelf. Wide strips

of tin may be tacked to the rafters to prevent the ascent of mice and rats.

Another method is to "string" the corn by taking four strands

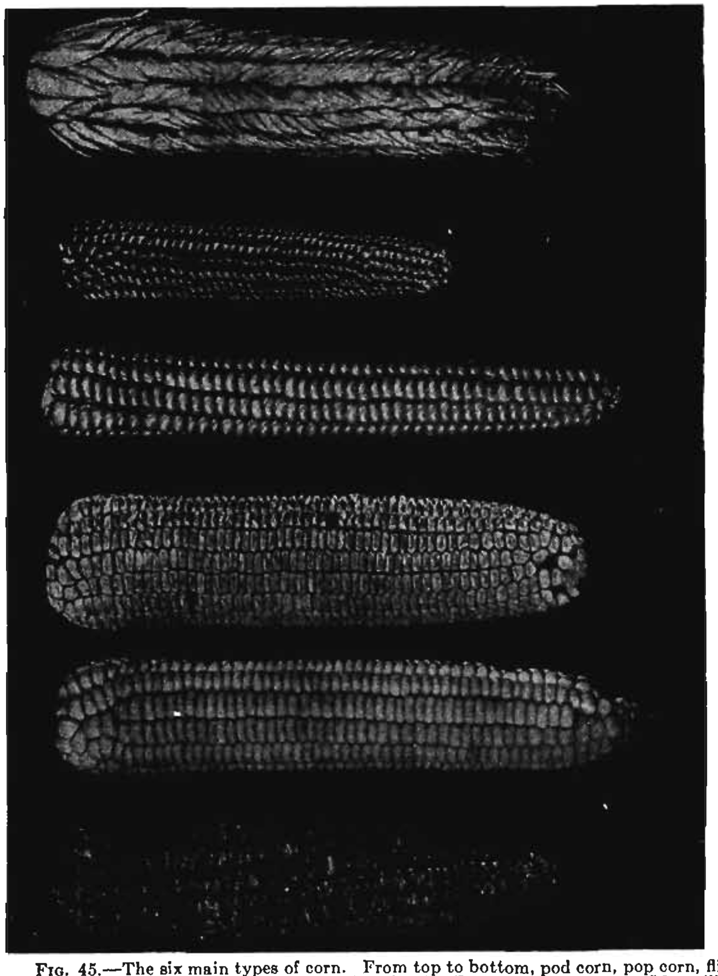


FIG. 45.—The six main types of corn. From top to bottom, pod corn, pop corn, flint corn, dent corn, flour corn, and sweet corn. (*Productive Farm Crops*, Courtesy, Macmillan Publishing Co.)

of binders' twine, and weaving them with the ears back and forth in pairs in such a manner as to support ears of corn placed between them, as woof and warp are woven in cloth.

Another good plan is to drive ten-penny finish nails on four

sides of a small timber as a two by four. These nails are left projecting sufficiently so that each will receive an ear of corn, placed with butt end toward the timber, the head of the nail projecting into the pith of the cob. The timber may be supported from the ceiling or rafter by a piece of wire passing through a hole bored in the upper end.

In southern states where weevils and grain moths are serious, the corn, after being dried, may be placed in a barrel or metal can and tightly covered. To be certain that no weevils or moths are in the corn when it is stored, it should be given a treatment of carbon bisulfide at storage time. Use a tablespoonful of the volatile liquid in a saucer placed on top of the corn and then cover tightly.

Sometimes corn growers try to prevent attacks of weevil during storage by leaving the ears covered with their shucks. This does not allow the corn to dry as readily as it should and mold is likely to attack the corn. Corn thus stored has a low percentage of germination. This is particularly true if there is freezing weather early in the storage period, before all moisture is removed.

Injury During Storage.—Weevils and grain moths lay eggs on the kernels of corn and the larvæ feed on the kernels, eating out the "hearts" and starchy matter. In many cases almost every kernel in a lot of seed corn is thus attacked and will not germinate.

When rats and mice attack stored corn they always prefer to eat the germs if they can get to them. Small mice sometimes attack only the crowns of the kernels because they seem unable to shell the ears. Such slight attacks may be taken as warnings to keep the enemies away.

Molds and rots of several kinds attack moist corn and greatly reduce its power of germination.

Freezing and thawing when the kernels are moist produce a similar effect.

Types of Corn.—In choosing corn to grow we must first decide which of the six types of corn are suited to our purposes. The six types arranged with the most important first, are dent, flint, sweet, pop, soft, and pod corn. (Fig. 45.)

Dent corn makes up nine-tenths of the entire crop of the world.

Flint corn is a field corn grown in the colder climates. The kernels are smooth and flinty in their crowns and are not dented.

Sweet corn has a larger percentage of sugar than the preceding types and is much grown in gardens for table use.

Pop corn is well known by all because of its power of popping, due to a volatile oil which explodes with heat.

Soft corn is sometimes called flour corn and is grown only in warm latitudes, as Mexico and Central America.

Pod corn is not commercially grown. Each kernel of the corn has its own covering of husks. This form seems to be an inter-

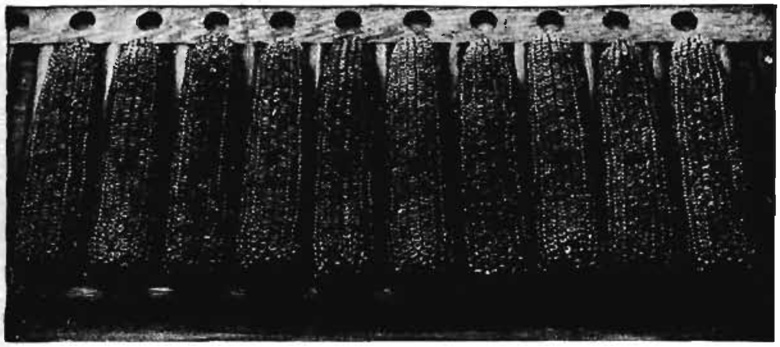


FIG. 46.—A ten-ear sample of yellow dent corn, on a corn judging board. (Agriculture and Life.)

mediate stage between the present commercial forms of corn and the wild plants, from which corn is developed, as teosinte.

Varieties of Corn.—After deciding upon the type of corn to be grown, the next step is to determine what variety is best for

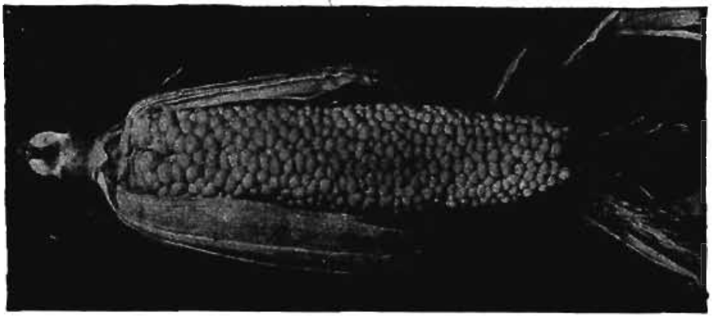


FIG. 47.—Country Gentleman is one of the best varieties of sweet corn, medium in season. (Pedigreed Seed Co.)

the region and soil. There are perhaps many different varieties offered which suit your region. (Figs. 46 and 47.)

One of the best ways of solving this variety problem is to make a regional survey, as some of these varieties are better suited to rich soils and others to poor soils, some to uplands and some to lowlands, some to early planting and some to late, some to produce fodder or silage and some to produce grain. It is necessary to

take all of these points into consideration while studying the varieties of your region.

Make *a table on a large sheet of paper giving one column* for each of the above-mentioned points. At the left of the table leave room for a list of the varieties of the region. As each corn grower is visited, record in the table, opposite the variety he grows, a mark to indicate the conditions, purposes or seasons. The result of this study should indicate clearly what variety you should grow. Another method is to describe your soil, conditions, and purposes to such authorities as the state corn specialist at the experiment station, the county agent, or some teacher of agriculture. The advice thus gained may be the best way of choosing your variety.

Color of Corn.—Some sections of the country are partial to white corn because it is used for milling purposes and made into white meal. Other sections of the country prefer yellow corn. There is no important difference between varieties due to color. Chemical tests do not show that one color is preferable to another because of any difference in composition, except, undoubtedly that vitamines are greater in yellow corn. Red corn is seldom grown commercially, but is often found in impure fields.

FIG. 48.—At first use the corn score card in selecting corn and later its aid will not be necessary. (I. H. Co.)

Corn Judging and Culling Ears.—After corn has been well cured it is in the best condition for judging exercises. That is the best time to cull over the seed corn and select the best ears. (Fig. 48.) If plenty of corn has been gathered and saved, close culling can be practised. To attain the highest skill in culling, one should have considerable practice in corn judging. Tablets of corn score cards can be obtained from supply houses. It is usual to select ten rather uniform ears for practice in scoring. The student may place these ears on a table in front of him with the butts all even. Take two kernels from the central portion of each ear and place them opposite that ear. With the score card in hand, score each ear separately on all of the points mentioned in the score card.

Variety Characteristics.—All the ears should be similar in shape and depth of kernels, shape of ears, denting of crowns, size and color of cob, starchiness or flintiness, and appearance generally.

Careful observation will show what the type should be for that variety. Any variation from that type should be scored accordingly.

Shape of Ear.—Most ears should be nearly cylindrical, tapering only slightly. Cut for any undue tapering or for irregularities in shape.

Length of Ear.—Varieties differ in length of ear. It is well to have a foot measure handy, or if the corn is placed on a corn-judging board, the measure may be indicated on the margin of board. Deduct from ears that are too short but not from ears that are extra long unless extremely so. Uniformity in length is desirable.

The range in length for dent varieties is about as follows: Northern section, seven to nine inches; central section, eight and one-half to nine and one-half inches; southern section, ten to twelve inches.

Circumference of Ear.—Measure small, medium, and large ears by using strips of paper placed around the ear about one-third the distance from butt to tip. Uniformity in circumference is desirable in any sample of corn. Discard or cut the ears that are extra large or small. Determine the proper circumference for any variety by measuring a number of ears. In general, circumferences of dent corn range about as follows: Northern section, six and one-half to seven inches; central section, six and three-quarters to seven and one-quarter inches; southern section, seven to eight inches.

Some varieties will vary beyond these dimensions.

Purity of Corn.—Most varieties of white corn should have a white cob, and yellow corn should have a pink or red cob, but certain varieties break this rule. Mixture in a mature lot of corn indicates impurity and should be scored zero on this point. Corn so mixed will not come true to variety when planted.

The grain should be uniform in color. Look each ear over carefully and see if any signs of impurity are indicated. Sometimes a few flinty kernels are found in ears of dent corn, possibly sweet corn kernels may be found there if corn had crossed in the field. Do not mistake discoloration due to mold or rot as a sign of impurity. Cut severely any possible signs of impurity.

Vitality.—Will the corn grow? This must be answered by careful examination. It should appear to be sound. When bent or twisted the kernel should be firm on the cob. A squeaking of kernels against each other when bent indicates this. The size of the germs and the kernels, and plumpness of germ are favorable. Vigorous growth and heavy yield indicate strength. Any signs of freezing, mold, rotting, or any other injury from exposure indicate low vitality. In northern sections immaturity is commonly found and should be cut. When kernels are removed from the cob the mature ones will have neither adhering chaff nor black tips.

Size and Depth of Kernels.—Deep kernels on small cobs give much more corn to the ear than shallow kernels. Uniformity of kernels in shape and size is desirable because of even planting by machines. Strive to have uniform kernels in all ears.

Shape of Kernels.—The best shape is to have the kernels taper from crown to tip and to have tips that are not too broad. This will prevent having any space between kernels at the tip and very little space between the crowns. Run your finger or pencil point down the grooves and note the variations in these grooves. When a few kernels are shelled, space between the tips of those remaining may be detected. The kernels should be large enough to have large germs. This part of the kernel is rich in protein and oil and is of high feeding value. Large germs also indicate vigorous growth.

Proportion of Corn to Cob.—It is important to have a large supply of real corn on every cob. Deep kernels, small cobs, narrow furrows, no spaces at cob, all indicate good proportion of corn. If desired an average ear may be shelled and weighed. Shell the kernels from one ear and weigh in a small paper bag. If the weight of entire ear, cob and kernels, is called 100 per cent, the kernels should weigh 86 or 87 per cent of this, and the dry cob only 13 or 14 per cent. In seed corn it is very important to have corn as nearly up to this standard as possible.

Butts.—The cob should not be swelled near the butt. The shank or stem should be small. The rows of kernels should extend over the butt to the shank and be nearly in regular order. When the stem is removed there should be a deep depression left.

Tips of Ears.—Tips should not taper too much. The rows of kernels should be well carried out over the cob. In perfect tips the kernels are nearly uniform in shape and will entirely cover the cob. Length of ear

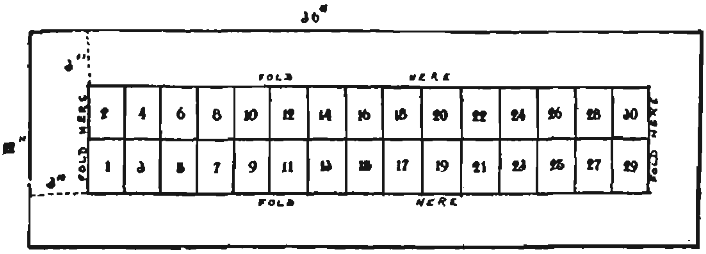


Fig. 49.—Cloth marked for testing a few kernels from each of thirty ears, by the rag-doll method.

should not be sacrificed in securing perfect tips. This would tend to reduce the yield of the corn in the field.

Testing Seed Corn.—Each ear of seed corn should be tested and those imperfect in germination should be separated from the rest and not used for planting unless it is absolutely necessary. Purposes accomplished by testing seed corn are the following:

1. Poor stands of corn are less likely to occur.
2. Replanting of fields of corn is avoided.
3. Germination and growth will be more uniform.
4. Cultivation may begin earlier.
5. Corn is saved, as less seed is required.
6. Corn of low vitality may be used for feed.

Methods of Testing.—Several different methods are in use. In any successful method the corn must be kept uniformly moist during germination. The temperature should be that of the ordinary living room and not too cold at any time.

1. *The rag-doll tester* is probably the simplest and gives good results. With a soft, black pencil mark off blocks about two inches square on a strip of cloth about twelve inches wide and thirty-six inches or more in length. (Fig. 49.) Leave margins for folding as shown in the figure. Number the squares and number ears to correspond to these. Fasten the

number securely to the ears by putting a small nail through the number tag into the end of the cob. From ear No. 1 take five kernels, avoiding the tips and butts. Place them on square No. 1. Continue until all the ears are thus sampled. Fold the margins of cloth over the kernels and then roll the cloth with a stick or pencil inside to assist. When this core is removed place a few rubbers or some string around the roll and soak the "doll" in water for about twelve hours. Then remove from the water and place in a covered jar or vessel to hold the moisture for a few days until germination is complete. Keep the vessel in a warm place all the time. When unrolling doll avoid mixing the kernels from different squares. Examine all the kernels on each square and record the percentage

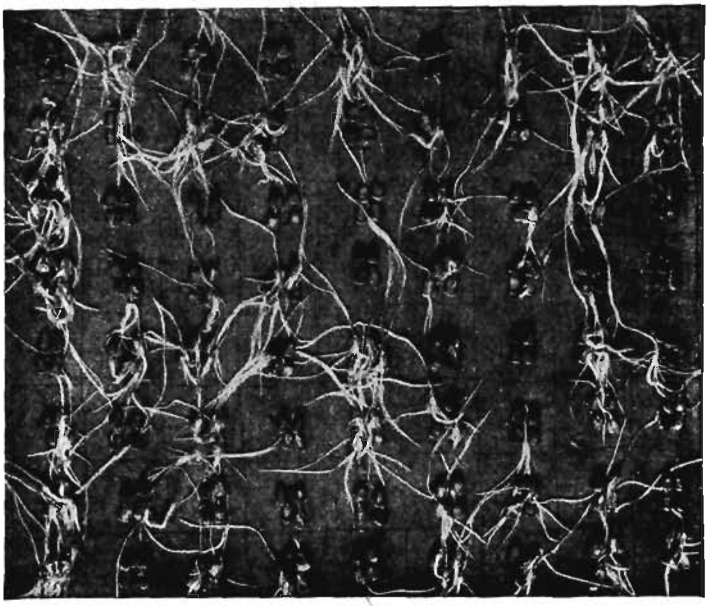


Fig. 50.—Result of a test of 72 ears of corn. Note which are weak and which are strong.

of germination for each ear in a list. Small sprouts may be given little or no credit. When the record is completed locate and discard the ears not good for planting. (Fig. 50.)

2. *Tray testers* may be filled with moist sand and marked off in squares with wire or string stretched between nails driven in the edges of the wooden tray. Sample kernels may be placed in the squares—five from each ear. After germination the poor ears may be readily discarded.

3. *Plate testers* are made by taking a number of plates or saucers and a sheet of blotting paper for each. Sample kernels from each ear are placed on a wet blotter or between two wet blotters on the plate. Each plate is numbered to correspond to the number being tested. The plates are placed in order in a stack and kept moist and warm until the test is complete. Then the poor ears are located and discarded.

Winter Study of Corn.—1. Examine kernels of corn of several different varieties. Cross-sections and long-sections of kernels should be made. Draw several of these sections showing the variations in size of germs.

Study the proportion of starchy, flinty matter and germ. Represent all of these in drawings.

2. Soak a number of kernels of corn for a day or more. Study the coats and the layers at the tips of the kernels. Remove some of the germs and study them as closely as conditions will allow. If possible make thin sections and mount them for study with a high-powered microscope. Make drawings to show the corn plant in the germ.

3. Compare the kernels of four types of corn, dent, flint, sweet, and pop corn. (Fig. 45.) Which have the regular amount of flinty matter? Which the most starch? Which have largest germs in proportion to size of kernels? In feeding tables compare the percentages of protein in flint and dent corns.

4. A series of samples of corn products in bottles obtained from supply houses or from manufacturers, should be studied. Make a table showing the percentage composition of each of these ingredients in an average lot of corn, on a chart showing the parts of a corn kernel or on a drawing made in one of the preceding studies. Locate the chief seat of the component ingredients. Make a list of commercial uses of each of these ingredients.

Winter Studies of Ripe Corn Plant.—Entire corn plants of the preceding year's growth may be selected for study, that is, those which have lost as little of the leaf and tassel as possible. Study the relationship and uses of parts: Silks, tassels, shucks, leaves, sheaths, joints, rind of stems, pith, fibro-vascular bundles in the pith, brace roots, and other roots. Compare full-sized ears with nubbins and buds at other joints.

Fodder Studies.—In barn lots or fields compare several samples of corn fodder or corn stover (fodder without ears). See which have kept the color best and which are best in aroma, which have lost fewest leaves, which are finest in stem, which are naturally best suited for feeding as roughage. In studying each of these points give reasons, if possible, for the conditions you find.

Studying Samples of Silage.—Obtain a number of samples of corn silage for study or go to the silos to make the studies. Use the following suggestions and compare the different lots of silage in feeding qualities. (a) Fineness of cut or shredding. (b) Proportion of grain found. (c) Moisture or dryness. (d) Freedom from mold or rot. (e) Color, aroma. If convenient make field tests of the different lots of silage and weigh a bushel of each, either loose or packed.

Winter Study of Corn Soils.—Obtain fair samples of the top six inches of soil from several fields intended for corn growing. Compare them in their water-holding powers. Compare them also in the percentages of organic matter. After making these studies decide which you think will be best for corn growing. How could the poor fields be improved? Suggest ways of improving. Would the turning over of cover crops, as green manure, help any of these fields? Which ones?

Winter Application of Manure.—One of the best times to apply barnyard manure to corn fields is during the winter season. Avoid driving on fields when they are too muddy. Manure spread directly upon fields is less likely to lose from leaching or heating than if it is kept in barnyards. The manure should be spread evenly and thin enough so that all of the field needing it may be completely covered. The high spots need more than the low. Manure spread broadcast during the winter may be plowed under in early spring.

Fertilizer for Corn.—During the winter is the best time to study the fertilizer needs of a corn field. Preceding crops will strongly indicate what plant foods are needed. If the yield of ears has been light and the stalk growth heavy, possibly more potash and phosphate are needed. If the leaf growth has been abundant but the stalks are not large, more phosphate is needed. If the leaf growth and stalk growth are both too limited, more nitrogen and phosphate are needed. In other words, nitrogen produces leafy growth in abundance. Phosphate increases stem growth and assists in producing more ears. Potash is essential to produce starch and hence the ears are increased by its application. A soil rich in organic matter usually needs very little additional nitrogen in the form of commercial fertilizer. Heavy clay soils usually need very little additional potash. Soils that are sour, either from large amounts of organic matter or from other causes, need lime. A medium loam which in the past has been *producing a well-balanced* growth with about thirty bushels of corn per acre, probably needs a well-balanced commercial fertilizer, which would be composed of nitrogen, phosphoric acid, and potash in one of the following proportions: 4-10-6, 5-9-5, 4-11-9. These vary with the proportion of original fertility in the soil. Sandy soils need more potash. Organic soils need less nitrogen. If enough green manure is supplied, commercial nitrogen may be omitted.

Home Mixing of Fertilizer.—With the principles given in the preceding paragraphs each corn grower should decide as nearly as possible what fertilizer will be required for his own corn field. During the winter obtain the ingredients for home mixing of fertilizer. Suppose the first formula is desired. Nitrate of soda containing 15 per cent available nitrogen may be used. Acid phosphate containing 16 per cent phosphoric acid may be used for the phosphate. Muriate of potash containing 50 per cent potash may be purchased.

To obtain an approximate ton of commercial fertilizer having the formula 4-10-6 would require 100 pounds of nitrogen, 200 pounds of phosphate and 120 pounds of potash. To obtain 100 pounds of nitrogen from nitrate of soda (15 per cent grade) would require as many as .15 is contained times in 100 or 533 pounds. To obtain 200 pounds of phosphate from acid phosphate (16 per cent grade) would require as many as .16 is contained times in 200, or 1,250 pounds. To obtain 120 pounds of potash from muriate of potash (50 per cent grade) would require as many as .50 is contained times in 120, or 240 pounds. These amounts of fertilizers may be purchased and mixed together during the winter, ready for use the next season; 533 pounds nitrate of soda, 1,250 pounds acid phosphate, 240 pounds muriate of potash, total 2,023 pounds.

How to Mix.—Select a smooth floor on which to mix fertilizers. Take the largest amount of the three kinds first. In the above case this would be the acid phosphate. Empty the bags on the floor and level the mass somewhat uniformly. Be sure all large lumps are crushed with the shovel. Place the other ingredients in layers on this in like manner. Use square-pointed shovels and shovel over the mass into another pile as in mixing concrete. The whole pile must be shoveled back and forth until it is all of uniform color. Resack the mixture and label each bag with the formula. (For reasons for home mixing see Index.)

Preparing the Seed Bed for Corn.—If a winter cover crop has been grown and if it had time enough during the fall or the mild days of winter to make a sufficient growth for green manure, this should be plowed under rather early in the spring, say four weeks or even six weeks before time for planting corn. In any case, whether a cover crop was grown or not, the corn soil should be plowed as early as this.

In cases where fall or winter plowing has taken place, the preparation of the seed bed should begin several weeks before planting time. Thorough preparation of the seed bed is exceedingly important in the production of heavy crops. Harrow the ground as soon as it is plowed in the spring or disk it early if the field had been plowed in the fall.

The period between this first spring preparation and the planting time should be considered a bare-fallow period. It may be stated as a good rule that each harrowing given the soil before planting will be more valuable in the growth of the crop than each cultivation after the crop is growing. There are several definite benefits resulting from the maintenance of a good bare-fallow before planting time:

1. Weed seeds are sprouted and killed.
2. Surplus water is allowed to percolate downward for future use of the crop.
3. If the spring be rather dry, soil moisture is conserved by the dust mulch. A crust should not be allowed to form.
4. Soils are warmed to sufficient depth to cause prompt germination of seeds, and planting may take place earlier.
5. Soil bacteria are greatly multiplied and begin their summer work early.
6. Chemical and physical actions in the soil are started so that plant food is made available for the young plants when growth begins.

Time to Plant.—In northern and central sections early planting is important. Hence the corn crop is apt to be killed by fall frosts before maturity. The growth should therefore begin early

so that corn will ripen before frost. Plantings may be made as early as the soil is warm and danger of spring frost is over. The bare-fallow plan of preparing the seed bed warms the soil and allows early planting. Corn should not be planted in cold, clammy soil. The seed is likely to rot and the weaker germs will not grow. Poor stands often result under such conditions.

In southern sections corn may be planted as soon as spring frosts are over, but as the growing season is naturally long, the times of planting vary considerably. It is not at all uncommon to plant silage corn after oat crops are harvested, but with such late planting as this, the crop is in danger of being reduced by dry weather and the yield of grain is never so large as when the whole season is used for its production.

Planting Corn.—A number of plans for planting corn are practised. Throughout the corn belt and a large majority of other regions, the ground is left level at planting time. In some other cases, because of wet weather, the soil is ridged and the corn is planted on ridges. In some dry regions furrows are plowed and a little top soil thrown back into them and then the corn is planted in the furrows. Planting with listers has this same effect. A lister is a plow with two moldboards. The lister serves as a planter also. The corn is dropped in the furrow and covered. As the corn begins to grow soil is worked toward the plants until the surface is leveled. This is usually done with the harrow; the first harrowing is with the rows and the next may be across them. In ridge planting of corn cross-harrowing is seldom practised. In the level system of planting corn two important plans are commonly found:

1. A two-row planter with a check-rowing device plants the corn in rows or squares so that it may be cultivated both ways. This plan is commercially used if the grain is to be grown and the fodder is of little importance. It is well suited to fields that are likely to be grassy and weedy. It suits level fields better than those where erosion is serious.

2. Planters dropping one or two rows at a time are used to drill the corn in the rows. One, two, or three kernels are dropped in each place and the stalks are usually closer together than the rows. The distances will vary with the richness of the soil, the type of corn, and the purposes for which the fodder is to be used. *i.e.*, for silage or for fine fodder, the drill is set to plant closer than if grain is the main object.

The same principle applies to the distances between the rows.

Varieties having large stalks and bearing two good ears are planted farther apart than varieties of smaller type. On poor soils corn is planted more open than on best soils.

Depth of planting varies to suit moisture and soil conditions. In dry soils and in sandy soils corn is planted four or five inches in depth. In clay soils or in wet weather the kernels may be covered only an inch or two.

The amount of seed corn required to plant an acre varies according to the distances and closeness already referred to. One bushel of shell corn will, on the average, plant about six acres. Five or six quarts of shell corn should plant one acre.

Companion Cropping for Corn.—In sections where soils are becoming depleted and in sections where livestock farming is important it is becoming more common to grow leguminous crops with corn. Cowpeas and soybeans are grown with corn in all sections of the country. Velvet beans and peanuts are grown with corn in southern states. It has been found by experiment that the use of such companion crops greatly increases the total yield of feed per acre. If corn is to be harvested by turning in livestock, such as hogs or steers, the gains in flesh are greatly increased by the presence of such legumes. Similar advantages are found when the crop is cut for fodder or for silage.

Even when the corn grain is gathered the yield of corn is not in the least decreased by the presence of these legumes. After gathering the ears, livestock are often turned into the fields to glean the fodder and pasture upon the legumes.

The planting of such legumes in corn is accomplished in several different ways:

1. By planting the corn and legumes together in the same planter.
2. By planting the corn first, and after it has been cultivated between rows a few times the legume seeds are planted in the rows by hand.
3. By cultivating corn until it is ready to "lay by" and then planting the legumes between the rows, either by hand or with a one-horse planter.

Modifications of these combinations are in use in different places. In the Gulf states and South Atlantic states velvet beans are commonly grown in corn fields and are planted by either the second or third method, the beans being used only every second or third row because the growth is so vigorous.

Cross-harrowing Corn.—As already mentioned, when corn is planted in furrows or by use of listers, the ridges between the rows are gradually worn down and the soil fills the furrows. The use of a spike-tooth harrow for the work gives the field excellent tillage. The young corn plants endure such treatment well, though many growers are fearful lest the plants be destroyed by the harrow.

In level planting of corn, cross-harrowing is more easily practised. The harrow should be used just after the corn is planted. As soon as the crop is up enough for the leaves to bend over a little, a second harrowing should be made. Little attention should be given to the rows except that the horses should not tread directly upon them. A spike-tooth harrow will readily till from three to five rows at once. A large field may thus be tilled in a few hours. This is much easier than cultivating between the rows with other implements. This work is more effective because all the surface is covered. Young weeds are killed before they show much. Soil moisture is kept in the right condition for the best growth of the crop.

Cross-harrowing may be continued at intervals of a week or ten days until the corn is so high as to be in danger of being broken off by the cross bars of the harrow. Weeders are higher and are sometimes used instead, so that such tillage may continue longer. One important point to remember in cross-harrowing of corn is, that when the plants are limp and not full of surplus moisture which accumulates during the night, less damage is likely to occur. In other words, do the cross-harrowing after the sun and wind have had time to do a little drying each day.

Tillage between Rows.—When corn plants are small, tillage between rows may be deeper than later on in the season. If the soil is of such character as to become hard from rains or from natural settling, rather deep cultivation at first is desirable. If the soil be light or somewhat sandy, shallow cultivation may be practised from the very first. Never allow the surface of the soil to become crusty. If heavy rains occur cultivate as soon after these as possible, waiting only until the sticky condition of the surface is passed. (Fig. 51.)

Intertillage should be continued until the stalks are so large as to be injured by the cultivation. (Fig. 52.) Little moisture will escape from the surface after the crop thoroughly shades it. One cultivation after tasselling may be given by using one-horse cultivators. Such late tillage is advisable only where a bad crust is forming or when weeds are bad.

Tillage Implements.—A two-row cultivator drawn by two horses or a tractor allow the corn grower to cultivate very economically. A one-row cultivator that straddles the row and is drawn by two horses is a very popular cultivator in the corn belt. One-horse cultivators that fill the entire middle between two rows do as rapid work as the preceding type and save the time of one

animal, the driver, however, is required to walk. Such cultivators work best when the spaces between rows are somewhat uniform.

Small implements that cultivate only one-half of a middle are wasteful of time by both man and animal. As many of these are in the form of "single-shovel" or "double-shovel" plans, they are subject to another serious objection, *viz.*, they usually go too deep and destroy many corn roots.

The shovels on cultivators should be small. If the type of soil is heavy the shovels may be four or five inches in width, but lighter shovels should be used on medium loams and light soils.

A large number of shovels do better work in the corn field

FIG. 51.—Riding cultivators with small shovels are much used by corn growers in all sections of the country. (Bateman Mfg. Co.)

than a few large shovels. Spring-tooth cultivators do very satisfactory work in most soils if they are not set to run too deep. In land filled with rocks or tree roots, spring-tooth cultivators are less subject to breakage than ordinary shovel cultivators. Disk cultivators are sometimes used by corn growers. They are objectionable because of cutting corn roots severely and because of throwing the soil too much to one row or another. In very grassy fields they meet with much favor.

A Corn Seed Plot.—A farmer growing corn as an important part of his farming enterprise should plan to produce his own seed corn free from crossing. At any rate, a few farmers in every neighborhood should produce good seed corn for themselves and neighbors. With a little extra care pure corn may be bred and sold for seed at a good profit.

Corn is naturally cross-pollinated by the wind carrying pollen from the tassels of some plants to the silks of others. If these plants be of different varieties cross-breeding occurs. To prevent such cross-breeding grow one variety only and locate the seed plot at the westerly side of the main field or in a separate field west

of the other corn. Be careful that a neighbor's field is not too near this on the west. In most states where corn is grown the prevailing wind during the season is from the west. If corn has been selected as directed in the early part of this chapter, it is important that no crossing with inferior corn be allowed, particularly in that part of the field where seed is to be selected. Before pollination takes place go through the part of the field where seed is to be saved

FIG. 52.—An extra cultivation with a 14-tooth cultivator may pay if the season is dry. (Florida Station.)

and detassel all barren or unproductive stalks. This insures good male parents for all the seed corn.

Corn has been found to be more vigorous and productive if the pollen is carried from one stalk to another, *i.e.*, if self-pollinating does not take place. For this reason it is profitable in producing seed corn to detassel every alternate row. The seed corn is then selected from the detasselled rows. Thus all such corn is produced by cross-pollination. All such detasselling work is done rapidly by using a heavy butcher knife or light corn knife. The tops are allowed to fall to the ground. Detasseling of a few rows will be sufficient for a large supply of seed corn.

The corn breeder should practise field selection of ears each fall before the main crop is harvested.

Insect Enemies of Corn.—When corn is germinating in the spring or soon after that, it is often attacked by cutworms. They are gray in

color and remain in the soil just below the surface during daylight. At night they crawl on the surface in search of food. When young corn is found they eat through the stem, thus destroying the plant. Sometimes whole fields are affected. They are seldom injurious if cross-harrowing is practised and if the bare-fallow system, already described, has been followed. If soils are thoroughly warmed before corn is planted, cutworms transform rapidly into moths and do no more damage that season. The cutworms are poisoned by spreading a bran mash in the field as a bait. Mix one pound of Paris green with 200 pounds of bran and moisten with water containing a little molasses. Avoid poisoning birds and poultry.

Corn ear worms are so well known that they need no description. Every grower or user of table corn knows them well. They are controlled chiefly by rotation of crops, fall plowing of soils, and the practice of allowing chickens to feed in the corn field. Birds, if protected, will destroy many of them.

Corn root worms attack the plants during the growing season. The southern form of this insect has at least two broods a year, the first attacking in May and June, or sometimes as late as July. The second does its damage after mid-summer. Most damage is done when the corn is young. The roots are destroyed by the larvæ. Later the bud is destroyed, which is more serious. From this habit the insect is sometimes called the "bud-worm." When the corn crop is attacked it should be heavily fertilized to force growth in spite of the attacks. Late planting in spring may aid in avoiding injury from this enemy.

Corn root aphis sometimes causes serious dwarfing of corn. The leaves turn yellow or red, and show starvation. This insect seems to be increasing throughout the corn belt and is spreading to other states. It also attacks crops of the sorghum family. Ants are usually present where root aphis is serious as they protect the plant lice in various ways. Rotation of crops will aid materially in checking the injuries. Heavy applications of fertilizer will also aid in overcoming attacks. Cross-harrowing of corn and other forms of thorough tillage aid in destroying ant hills and breaking up their nests.

The Corn Stalk-borer.—These are large, white caterpillars with brown spots, which bore into stalks of the corn. As this occurs when the plants are young the insects are sometimes called "budworms." The attacks of stalk-borers allow the crop to be blown down by wind. This results in serious damage. The borers spend the winter in the tap roots of corn and may be destroyed to a large extent in late fall by plowing and harrowing to expose them to the attacks of birds and frost. Rotation of crops will make injury less serious.

Chinch Bugs.—These are small sucking insects, black and white in color, which attack the corn plant, small grains and some grasses near the ground. They are sometimes so severe, particularly in dry seasons and in the drier parts of the corn belt, that they practically ruin the crop. The bugs live through the winter under rubbish. In the spring they lay eggs on young grain, grasses, or corn. Usually they attack grain fields and after these are killed or ripened the bugs spread to corn fields of the region. The young are reddish in color and cannot fly, but the adults fly on warm, sunny days to near-by fields.

The best remedy is to thoroughly clean up all rubbish in the fall where chinch bugs have been serious. Burn all trash in hedge-rows, fence-rows, borders of fields, along roads, and completely plow under everything on the field. In the summer when the bugs are ready to migrate to new fields, a plowed strip ten or twelve feet wide may be kept pulverized with the harrow. This will check the young bugs, perhaps, until they die, but it is not effectual in checking the adults. Large numbers of young bugs

may be killed in deep furrows by dragging a log frequently. Calcium cyanide can be used in post holes along a creosote or tar barrier in a furrow to kill the bugs. Trap crops as millet may be sown around corn.

Army Worms.—There are several types of army worms which may be injurious to corn, grain and other crops. They occur in large numbers only in certain years when their natural enemies fail to keep them in check. Sometimes outbreaks of them are successfully poisoned by spraying with arsenate of lead before they do much damage. Their progress may be checked by retarding their onward march as suggested for chinch bugs.

Grasshoppers.—These insects are sometimes so abundant as to do serious damage to corn, small grains and grasses. They seldom attack corn until after small grain of the region has ripened. Trap crops may be grown along the edges of the corn field, and sprayed with arsenate of lead as soon as they are attacked. Spraying a few rows of corn at the edge of the field may serve this purpose. The fodder would be sacrificed as it would then be unsafe for feeding to livestock. Fall plowing is an effectual remedy for controlling this insect as the eggs are laid in the ground in the fall. (Fig. 94.)

Diseases of Corn.—Corn smut often does serious damage to the crop. The large, black masses are more or less familiar to all. They are commonly found on the ears and tassels, but sometimes attack the stalks and leaves. Whole ears of corn are frequently destroyed by this disease. As the spores of this parasitic plant live over winter in the soil, in manure piles and in samples of seeds, there is no effectual method of preventing the disease. Very few of the germs are found on the seed corn and no treatment of the field can prevent the growth of the spores in the soil. Rotation of crops will have a good tendency. Manure may be applied to the grass or clover field preceding the corn crop, instead of applying the manure directly to corn land. In gathering corn, care should be exercised to avoid getting masses of smut in the crib, where it finds its way to barnyard manure. Experiments have been tried to test the effects on animals fed corn smut. These experiments prove conclusively that this matter is not poisonous to livestock. The so-called "corn stalk disease" is probably due to impaction of the rumen or from some other cause.

Other Enemies of Corn.—Sometimes crows, blackbirds, and gophers do serious damage to corn fields soon after germination. Birds pull up the corn to get the kernels at its base. Gophers sometimes dig up the grain before it sprouts. An effectual remedy is to treat the seed with tar. Place the seed corn in a vessel, then, with a paddle coated with a little warm tar, stir the corn for several minutes or until every kernel has taken on a thin coat of the tar. A little dust of lime or ashes applied to the corn after the tarring process will prevent the kernels from sticking together at planting time. Gophers and birds do not like corn so treated and are likely to do the field no harm.

Crows and blackbirds often attack shocked corn or mature corn in the field. The best remedy against this is to harvest the ears of corn as soon as cured.

Methods of Harvesting Corn.—In all regions a number of methods of harvesting corn are found. Chief among these are the following:

1. Gathering and husking the ears, leaving the husks upon the stalks in the field. This plan is followed in all parts of the corn belt. This "gathering of corn" is mostly done in the warm weather following killing frosts, but some of it may be delayed

until mid-winter. Usually the ears are thrown into a wagon driven through the field at harvest time. In other cases the corn is thrown in piles and later hauled in to cribs.

2. Ears are snapped with the husks on and hauled into cribs at snapping time or just a few days later. This is a common method in southern states where grain moths and weevils are too serious to allow the removal of husks.

3. Corn fodder is cut near the ground and put in shocks to cure. Cutting is done by hand or by corn harvesters and binders. A two-row cutter drawn by one horse is a very inexpensive and economical machine. Corn cutting is done before the corn is dead ripe and before killing frosts occur. The corn completes its ripening from starch in the stalks. Some weeks later the ears are husked from each shock and hauled to the cribs. The stover is of great value as roughage for stock. The corn fodder from the shocks sometimes is run through machines called "shredders," which have husking rolls to remove the ears. The stalks are finely shredded and fed to livestock. The extreme wastes from broken ears, shelled corn, and the molding of the shredded fodder are the chief objections in moist climates.

4. Pulling "fodder" and topping corn before the ears are mature are two methods sometimes found in southern states. Experiments have shown that these practices greatly reduce the yields of grain and are very expensive because of the hand labor involved.

5. "*Hogging-off*" corn or otherwise harvesting the corn with livestock is an economical method which seems to be growing in popularity. After the corn is ripe a small portion of the field is separated from the rest by a temporary fence. This may be made of low woven wire supported by tying to corn stalks and by the use of a few sticks or posts, particularly at the ends. Plow a furrow beside a corn row, put wire in place and then throw soil back to it. The difficulty of supplying water to the hogs or steers in the corn is overcome in various ways. The temporary fence is moved over from time to time as the corn is exhausted. Animals fed in this method gain rapidly.

6. Corn is often cut in the roasting ear stage and fed to dairy cows and other livestock to substitute for or supplement pasturage. The system of feeding green forage is called the "soiling system."

7. Corn is cut for silage in the immature stage. In modern practice it is allowed to more nearly mature than formerly. If it is a dent type of corn the denting of the kernels should have taken

place before harvesting for silage. Greater yields of feed are thus secured.

Making Silage.—Silos are usually built in cylindrical form (Fig. 53) with air-tight walls, smooth inside. They are filled at a window opening near the top, or when roofs are not used the filling is done at the top. Small doors are placed in a column

FIG. 53 —Hollow tile silos are very durable but the first cost is high. (*Florida Station.*)

on one side for the removal of silage at feeding time, the top being used first.

Silage cutters are of several types. The more modern makes have blower attachments, by which the finely cut fodder is blown up through a pipe into the silo. Tractors or other gas engines are perhaps the most common form of power used for running silage cutters.

Usually the whole stalks including the ears are fed into the cutters, but in some cases farmers remove the ears for use in feeding horses and hogs before making silage. This plan requires that corn be rather mature before harvesting. To prevent the silage from molding water is run into the silo during the filling process.

Yields of Corn.—The average yield per acre of corn, including both good and bad fields, ranges from twenty-six bushels in poor

years to thirty-three bushels in good years. In boys' corn-club contests yields of one hundred bushels per acre are very commonly produced, and two hundred and twenty-six bushels on a single acre were produced by one club boy. Throughout the corn belt good corn growers commonly produce forty-five to sixty bushels per acre. The yields in different states and on different soils vary greatly.

Yields of green corn fodder, including ears when made into silage, may be closely estimated. The capacities of silos being known and the acreage cut to fill them being known, the yield per acre is easily calculated. This varies with the type of corn as well as with the length of season and character of soil. Ask farmers of your region how many acres of corn it takes to fill their silos. Dry corn stover is fodder from which the ears have been removed. This weighs about the same or a little less than the ears removed from it. If corn ears weigh seventy pounds to the bushel after curing, if we know the number of bushels per acre, we can calculate the tonnage of ears. From this we can estimate the corn fodder to be about equal or a little under the weight of ears. The feeding value of stover has been experimentally found to be about 37 per cent of the entire crop.

Storage of Corn.—Methods of storing seed corn were discussed earlier in this chapter. Corn ears with or without the husks should always be stored in well-ventilated cribs to prevent molding. The cob and grain hold so much moisture that storage in large masses would cause heating or molding. The plan of building cribs with wide roofs aids greatly in preventing rain from blowing in on the sides of ventilated cribs.

Danger from rats and mice in stored cribs is readily met by the use of woven wire, sometimes called hardware cloth, having meshes of about one-fourth inch. This wire is used to line the floor and sides up to the roof. If properly installed it is very effective in excluding rats, mice, and sparrows.

Care of Stover and Fodder.—As already mentioned, shock corn should be allowed to cure somewhat in the field before moving to the barnyard. Stover, when thoroughly cured, may be stacked in small ricks or round stacks in convenient places for use in feeding to livestock through the winter. It should never be put in very large stacks because of the danger of spoiling. In dry climates this danger is less apparent.

Uses of Corn Stover.—The feeding value of well-cured corn stover is quite commonly underestimated. It is used for feeding

cattle, sheep, and idle work stock during the winter. By these it is highly relished, particularly during the early part of winter. It is rich in starch and other carbohydrates and is of much value in a maintenance ration for livestock. It may be either fed whole or cut up or shredded. Wide troughs or racks should be used rather than to feed the stover on the ground. This wasteful method is too often found. Corn fodder, including the ears, is fed in much the same way as corn stover.

Market grades of corn for white, yellow, and mixed have been established: Nos, 1. 2, 3, 4, 5, 6, and "Sample." The federal standards for the six main grades are here given in table form.

Grade No.	Minimum test weight per bushel.	Maximum limits of—			
		Moisture.	Foreign material and cracked corn.	Damaged corn.	
				Total.	Heat damage.
	Lbs.	%	%	%	%
1	55	14.0	2	2	.0
2	53	15.5	3	4	0.1
3	51	17.5	4	6	0.3
4	49	19.5	5	8	0.5
5	47	21.5	6	10	1.0
6	44	23.0	7	15	3.0

Optional Studies—Origin of Corn.—Corn belongs to the grass family, but none of the so-called grasses resemble it very closely. Teosinte, a large, wild plant of Mexico and Central America, is probably the nearest relative. Gama-grass is another relative. Recent plant-breeding experiments have succeeded in reproducing corn from its wild relatives.

It is well known that when America was discovered Indians were found growing corn. Columbus is said to have introduced the plant into Europe from America. From thence it was brought to the United States by the early English settlers of Virginia. These types of corn have been greatly improved by selection since that time.

Surveys, Trips, Exercises, Projects and Problems

Several winter exercises have been suggested in this chapter, including field selection of seed, judging and testing seed corn, home mixing of fertilizers and others.

1. **Corn Survey.**—Make a few questions to be used in a survey of the neighborhood. These may be written, printed, or mimeographed on cards, one for each farm to be surveyed, including such points as the following: Variety grown; use of bare-fallow; date of planting; other crops in the corn rotation; green manuring; fertilizing; cross-harrowing; number of cultivations; harvesting; yields; use of crops; weed troubles; insects; winter cover crops; fall or spring plowing.

2. **Gather data** from farmers, club members and students with projects regarding cost of each of the farm operations in the production of corn.

From these calculate the total cost of productions of corn per acre and per bushel for your section.

3. **Corn Problems.**—From the data secured in the corn survey or from other facts obtained from corn growers, calculate yields of green forage per acre. Also calculate the average yields of dry stover or corn ears, of silage for your region or county. The number of acres of corn in a county can be obtained from census figures or from agricultural reports. Calculate the amount of silage made in a day and from this determine the size of a silage-man-unit.

4. **Survey Returns.**—Tabulate the results of the corn survey, using each question separately or grouping them to suit. Compare yields with methods used.

5. **Corn Charts.**—Students may make charts on sign cloth or cardboard with sign-writers' pens or small brushes. Study the wording of each chart carefully before making it. Good subjects for corn charts: Corn-judging points, points in field selection, reasons for home mixing fertilizers, soil types *vs.* yields.

6. **Collect pictures of corn** showing good and bad ears, or good and bad practices, corn machinery and others. Get these from bulletins, catalogues, and agricultural journals. Mount the pictures on gray cardboard of standard size either twenty by twenty-six inches or twenty-two by twenty-eight inches.

7. **Debates.**—Students should plan to have debates on such topics as the following: "Is corn more important than clover in American agriculture?" "Home mixing *vs.* the purchase of ready-mixed fertilizers." "Bare-fallow plan *vs.* other common plans of preparing seed beds." "Green manuring *vs.* the use of barnyard manure, or *vs.* commercial fertilizers."

8. **Field Trips.**—Take several field trips to study corn at times most suitable. Make an outline of points to be included in each study. Some of the main points to study are silo filling; harvesting and storing; winter cover crops and erosion; preparation of seed beds and planting; cross-harvesting and other tillage.

9. **Corn-growing projects** may be planned by students living on farms or who can secure land for the purpose. Many of the headings in this chapter will suggest the steps in corn projects.

10. **Trials with Projects.**—Plan comparative methods in growing corn to demonstrate in various corn-growing projects the advantages or disadvantages of these methods, for example: Liming compared with no liming; green manure compared with barnyard manure and with commercial fertilizer; plowing, harrowing, and planting in the same week compared with bare-fallow methods; ridging compared with level planting and cultivation.

Questions and Investigations

1. Do you live in one of the corn belt states? How does your state rank in the production of corn in the Union?
2. Compare corn with kafir in moisture requirements.
3. Describe a good corn soil. A poor corn soil.
4. Compare fall plowing and spring plowing for a corn field.
5. What benefits are derived from growing a winter cover crop?
6. Give the several points to be observed in the selection of seed corn. When is it done?
7. Describe a good place for curing and storing seed corn.
8. Name the several varieties of corn found in your region. Compare them.
9. Discuss judging points: Trueness to type; shape of ears; vitality; size and shape of kernels; proportion of corn to cob; butts; tips.

10. Enumerate the purposes of seed testing. Describe a good method.
11. Tell how to compound a good fertilizer.
12. Give reason for home mixing of fertilizers.
13. Describe the preparation of seed bed for corn.
14. Give arguments for the bare-fallow plan.
15. Describe the best planting methods of your region.
16. Give reasons for cross-harrowing corn.
17. Describe tillage implements and intertillage.
18. Why should the grower have a special corn seed plot?
19. What insect enemies of corn are worst in your region? How controlled?
20. What companion crops are grown in corn fields locally and elsewhere?
21. Describe the methods of corn harvesting which you have seen or which are used locally.
22. Describe the making of silage.
23. Compare local yields of corn with those found elsewhere.
24. Describe the storage of corn, fodder, and stover.
25. Mention valuable points found in local survey and field studies.

Farm Mechanics.—Build or repair corn crib to make it bird and rat proof. Make weevil treating-bin for seed. Make seed testing and curing rack; bushel crates; seed shipping crates. Repair planters; cultivators; harvesters; silo machinery; low frame for hauling fodder for silage.

Calculations.—1. Experiment stations have proved that the stalks and leaves of corn contain ⅔ as much feeding value as do the ears. What is the feed loss when only the ears are harvested from a 40-acre field yielding 42 bu. per acre, valued at 60¢ per bu.?

2. Find the crib space needed to store the above crop of corn.

3. What is the crib length for the above crop if the width is 10 ft. and the height is 12 ft.? Allow 2¼ cu. ft. per bu. of ears.

4. The owner of the field in problem 1 doubled the yield by planting corn after alfalfa. At present market prices of corn in your region calculate his extra returns in money.

5. The material for the crib in problem 3 cost $100, so the owner decided to build it enough smaller to save 40 per cent of the material. Then he would build a silo 30 ft. deep and 14 ft. in diameter at a cost of $120 for material. He also saves $200 on material by building a smaller hayloft in a new barn. What is his net saving?

6. If he fills the silo with the green fodder (including ears) from 15 acres of problem 1, what is the total value of feed stored in the silo?

7. How many cows would this feed if each cow received a cu. ft. of silage per day for 154 days?

8. A farmer with field and yields as in problem 1, increased his average yield of corn each year 5 per cent by field-selecting seed at a labor cost of $2. Find his net gain each year.

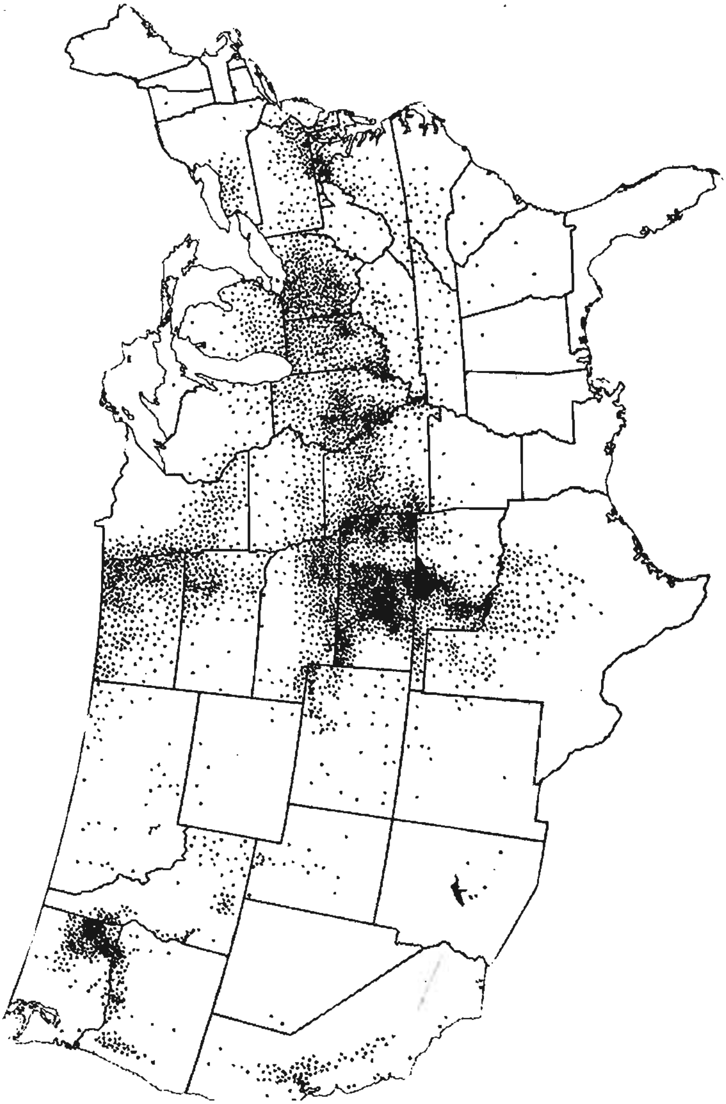


FIG. 54.—Acreage and production of wheat, each dot representing 200,000 bushels.

SMALL GRAIN ENTERPRISES

Analysis into Jobs.—The following teaching units include the main jobs in growing and marketing any one of the small grains: Wheat, oats, barley, or rye. References are given to pages in *New Agriculture*, Montgomery's *Productive Farm Crops* and to *U. S. Farmers' Bulletins*. See also *Field-Crop Enterprises* and *Southern Field-Crop Enterprises*.

1. **Deciding whether or not to grow small grains,** pp. 84, 85, 102, 106, 109, 111, 113, 114; *Farm Crops*, 104–108; *Bulletins*, 1358, 1464. *Local inquiry.*—(*a*) Which of the small grains are grown locally? (*b*) Give reasons for the popularity of certain ones over the others. (*c*) Ask farmers to compare small grain growing with other types of farming in returns.
2. **Choosing the crop, the type and the variety,** pp. 86, 107, 109. *Farm Crops*, 109–120, 148; *Bulletins*, 878, 1168, 1301, 1303, 1304, 1305, 1340, 1464, 1581, 1583, 1585, 1611, 1621, 1640, 1650, 1659. *Local inquiry.*—Find what varieties of small grains are used locally.
3. **Deciding acreage, soil, field and the rotation,** pp. 85, 86, 88, 102, 106, 111, 113, 114; *Farm Crops*, 123, 192, 200; *Bulletins*, 1358, 1464, 1545. *Local inquiry.*—(*a*) Find the small grain acreage on many local farms. (*b*) What local soils are preferred for each of the small grains? (*c*) What is the best grain rotation in your region?
4. **Securing, cleaning, and testing seed,** pp. 33, 36, 41, 91, 104, 107; *Farm Crops*, 128, 129; *Bulletins*, 428, 948, 1464, 1542. *Local inquiry.*—(*a*) How do most local growers secure good seed for planting? (*b*) Examine samples and pick out shrivelled, light and dead seeds and weed seeds.
5. **Providing organic matter,** pp. 46, 49; *Bulletins*, 1250, 1464; *Local inquiry.*—(*a*) How is organic matter supplied by the best local rotation system? (*b*) Get reasons from farmers who do not practice the addition of organic matter to the soil.
6. **Buying and mixing commercial fertilizer,** pp. 44, 45, 69, 70, 90; *Farm Crops*, 36, 37, 125, 158. *Local inquiry.*—(*a*) How do local farmers procure commercial fertilizer? (*b*) Give their reasons for and against home mixing of fertilizers. (*c*) How much fertilizer is used on small grain by the best growers?
7. **Liming the soil,** pp. 43, 44, 151, 161; *Bulletins*, 921, 1464. *Local inquiry.*—(*a*) At what time in the grain rotation is the lime usually applied? (*b*) Get the opinion of farmers on the best time to apply lime, the kinds and rates of application.
8. **Preparing the seed bed,** pp. 49–51, 88, 103, 107, 111, 114; *Farm Crops*, 124, 130, 159, 201; *Bulletins*, 1103, 1464, 1556. *Local inquiry.*—Describe the different local methods used in preparing seed beds for grain.
9. **Treating seed before planting,** pp. 92, 103, 107, 114; *Bulletins*, 1540, 1542. *Local inquiry.*—(*a*) Ask growers how much loss occurs from smut disease. (*b*) Describe local methods of treating grain seed before planting. (*c*) Find why some farmers do not treat seed.
10. **Sowing seed and fertilizing,** pp. 92, 93, 104, 106, 107, 110, 111, 113, 114; *Farm Crops*, 125–128, 163, 185, 200, 201. *Local inquiry.*—(*a*) Find the rates of seeding for each type of small grains grown in your region. (*b*) Why do these differ so much? (*c*) Find what farmers consider the best times for seeding each of these grains. (*d*) How many of the farmers apply commercial fertilizer at seeding time? How?

11. **Protecting winter grain,** pp. 51, 93, 321; *Farm Crops*, 128, 130; *Bulletins*, 1405, 1603. *Local inquiry.*—(*a*) Ask farmers how much loss occurs from winter damage in grain fields. (*b*) Ask them how ridging the soil when planting fall grain will help to protect the young crop. (*c*) Get their opinions regarding the use of livestock in pasturing grain in the fall or in open winter weather. (*d*) Get their opinions regarding the use of windbreaks.
12. **Seeding the field to clover,** pp. 92, 93, 104, 106, 110, 111, 113, 114, 159, 162, 163; *Farm Crops*, 401, 402; *Bulletins*, 1339, 1653. *Local inquiry.*—(*a*) Ask local farmers regarding the best time for sowing clover seed in the grain field. (*b*) What rates of seeding are followed?
13. **Controlling insects, diseases, and weeds,** pp. 76, 77, 93, 94–96, 110, 112; *Farm Crops*, 137–140, 166, 170, 185, 194; *Bulletins*, 660, 1006, 1217, 1260, 1414, 1483, 1498, 1540, 1543, 1544, 1599, 1607, 1627. *Local inquiry.*—(*a*) What are the chief diseases and insects affecting wheat or other small grains in your region. (*b*) What measures are taken to control these? (*c*) What weeds are most serious in local grain fields?
14. **Harvesting the crop,** pp. 96–98, 104, 108, 111, 113, 115; *Farm Crops*, 132, 167–169, 193, 201. *Local inquiry.*—(*a*) Get the opinions of farmers who have made hay from cereal crops. (*b*) Get their reasons for and against shocking and stacking.
15. **Thrashing the grain,** pp. 98, 104, 108, 110, 113, 115; *Farm Crops*, 132, 193, 201; *Bulletins*, 1565, 1608. *Local inquiry.*—(*a*) Get farmers to give their reasons for thrashing from shock or from stack. (*b*) Find the economical methods of managing thrashing crews.
16. **Storing grain,** pp. 97, 99, 104, 109; *Farm Crops*, 169; *Bulletins*, 1260, 1290, 1483, 1636. *Local inquiry.*—(a) Find the sizes and construction of grain bins. (*b*) Compare these with the acreage grown in each case. (*c*) Get the opinion of farmers as to the financial benefits of storing grain.
17. **Using the straw,** pp. 105, 115; *Farm Crops*, 154, 194; *Bulletins*, 1323, 1464. *Local inquiry.*—(*a*) What uses are made of straw locally? (*b*) Find the market prices of straw.
18. **Marketing and using grain,** pp. 99–101, 104, 105, 109, 113, 116; *Farm Crops*, 130, 133, 170, 201; *Bulletins*, 1144, 1232, 1260, 1290, 1464, 1483, 1542. *Local inquiry.*—(*a*) Find what proportion of the grain grown locally is used where grown. (*b*) What grades of each of the grains are produced? (*c*) Get the opinion of farmers for and against coöperative marketing.
19. **Keeping records and accounting,** pp. 18, 19; *Bulletins*, 511, 572, 782, 1182. *Local inquiry.*—(*a*) Ask farmers regarding the cost of each of the jobs in growing the leading local grain crop. (*b*) Compare the total costs with the income from the sales or use.

CHAPTER V

SMALL GRAIN ENTERPRISES

THIS term includes wheat, oats, rye, barley, rice, buckwheat, and flax. All of these with the exception of buckwheat and flax belong to the grass family, but flax and buckwheat are very different from grass in their characteristics.

The small grains all require similar practices. They are usually sown in narrow drill rows or broadcast and covered to a depth of one or two inches, depending on the texture and moisture of the soil. All of these except flax have habits of sending up several stems for each plant, a method of growth called tillering. The roots are fibrous. The season of growth is rather short and all are suited to rather wide ranges of climate.

WHEAT PROJECTS

This crop is more extensively grown and more widely used for human food than any other crop in the world, except rice. Production in the United States is shown in Figure 54. The importance of the crop in your own county can be determined by examining the last census report, by inquiring of farmers or county agents, or the state agricultural department. The profit in growing wheat depends largely upon the character of soil and the rotations followed.

Soils for Wheat Growing.—New soils are most productive. Old, worn-out soils give small yields unless ideal rotations and methods are followed. Wheat, like other members of the grass family, is better suited to growth on light, sandy soils. Those containing a fair proportion of clay are more retentive of moisture and fertility. They will remain good wheat soils for a greater number of years than will those containing a large proportion of sand and silt. Rich, black loams underlaid with clay are usually good wheat soils, but large amounts of organic matter are not so necessary or advisable as for corn.

Regions for Wheat Growing.—The map (Fig. 55) shows the districts of the different groups of wheat. In general the winter wheats are in the central and southern regions, while the spring wheats are confined largely to the northern region. (Fig. 56.) The crop is much better adapted to northern latitudes than is corn because it matures more quickly and endures more cold.

Choosing the Type of Wheat.—By the aid of the map one may decide which type of wheat is best suited to his own vicinity. (Fig. 55.) Both winter and spring wheats have hard and soft varieties. Decide which one of the following types would suit best for growing at home: Hard winter wheat; semi-hard winter wheat; soft winter wheat; macaroni wheat; hard spring wheat; soft spring wheat; Mediterranean wheat: durum wheat. (Figs. 57 and 58.) Note that along the Pacific slopes white winter wheats are chiefly

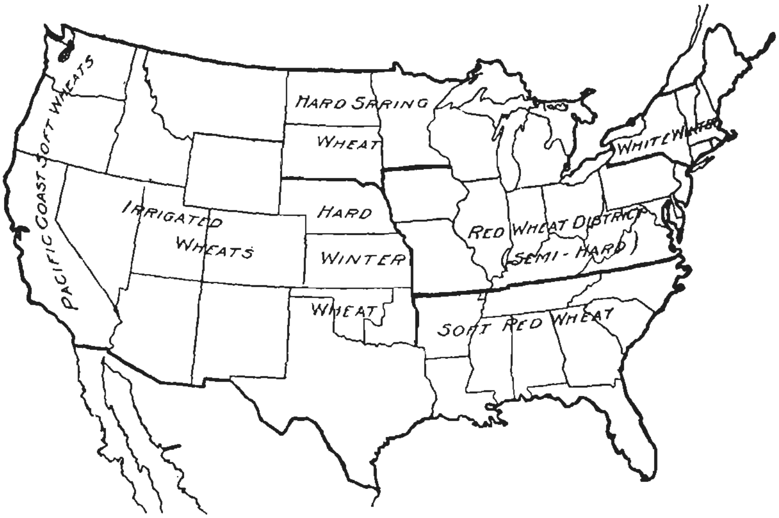


FIG. 55.—Regions for different types of wheat. (Montgomery's Productive Farm Crops.)

grown. Note that the region marked in figure 55 in the dry region east of the Rockies is durum wheat. It extends from Texas to North Dakota and Montana.

Ask wheat growers and seedsmen of your county what varieties and types of wheat are grown locally. Get samples of these and decide whether they are hard or soft, red or white.

Rotations for Wheat.—As the proper kind of rotation is so important in wheat growing, this should be considered before deciding on what field to grow the next crop. Wheat-growing sections of Europe and America have succeeded in devising suitable systems of fixed rotations, by which soil fertilizers suited to wheat may be fairly well and permanently maintained. These vary according to the soils of different regions throughout the middle and northern latitudes. The most popular three-year rotation in wheat

growing is wheat—clover—corn. The clover seed is sown with or in the wheat. *If the climate is rather severe spring sowing of* the clover in the wheat is practised. Clover is harvested the year following the wheat harvest. Usually two cuts are secured, one in June, the other in August or September. This leaves a good cover crop which is plowed under the following spring for corn.

The most popular four-year rotation for wheat is wheat—clover

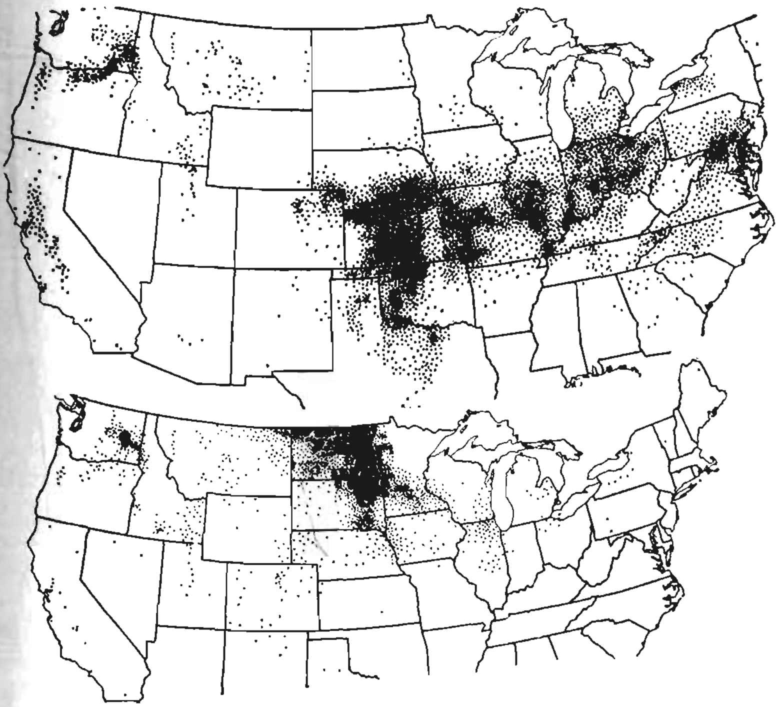


FIG. 56.—Distribution of winter wheat (above), and spring wheat (below), each dot representing 10,000 acres. (U. S. D. A.)

—grass—corn. The grass and clover are usually sown together in the wheat field and the grass remains one year after the clover harvest, otherwise the rotation is similar to the three-year rotation already described. The grass sod turned under is very favorable for the growth of corn.

In far too much of the intensive wheat-growing area wheat follows wheat for several years in succession. Experiments have proved that the results are very unsatisfactory. Yields are decreased even when manure and fertilizers are applied.

Applications of commercial fertilizers or barnyard manure are usually made on the wheat and on the corn. Lime is usually applied on the seed bed just before sowing the wheat. This remains beneficial to the clover.

Choosing a Field for Wheat.—Before undertaking the growth of a crop of wheat, judgment must be used in choosing the field. The rust disease is likely to be very severe if the common barberry is found near the field. It would be folly to expose wheat or other small grain crops of this type to the attacks of this disease.

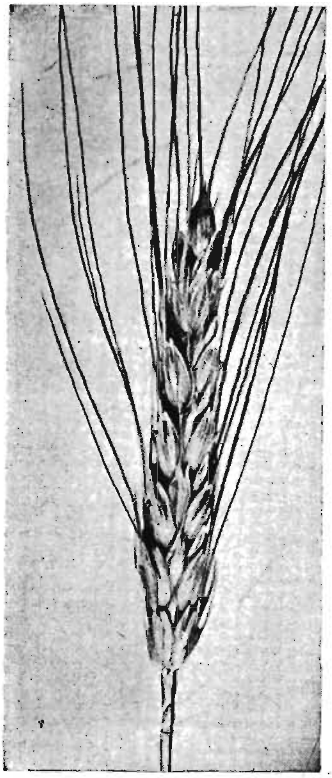


FIG. 57.—Head of Kanred hard winter wheat, producing better yields than Turkey and Kharhof. (Kansas State Agricultural College.)

Choose a field which has had a clean-culture crop the preceding year. If potatoes have been grown on the farm and have been harvested, that would probably be the best field to choose for planting wheat. The residue from fertilizing the potato crop is beneficial to wheat. Wheat may readily follow tobacco or corn. If wheat has been tried upon this farm before, choose, if possible, fields which are known to be productive for wheat. It is bad farming practice to have wheat directly follow wheat or other small grains continuously many years.

Preparing Fields for Wheat.—In spring wheat regions it is best to plow the field the preceding fall. This allows the ground to be ready for disking early in the spring. Early planting of spring wheat is absolutely necessary for success.

In winter wheat regions of the central and southern states as well as on the Pacific slopes the soil should be plowed several weeks before planting time. A rather firm seed bed is necessary. If for any reason there is not time for settling of soil after plowing, it should be packed with a subsurface packer such as a rough roller.

If the preceding crop has been free from weeds and grass and thorough tillage has been continued the soil may be prepared for

small grains by disking or double disking. Indeed, many wheat growers follow this practice for planting winter wheat.

When wheat is to be drilled it is important to have the field free from litter and it should be as mellow and smooth on the surface as practicable.

A bare-fallow period between plowing and planting times not

FIG. 58.—Three types of wheat. 1. Bluestem, red spring with hairy chaff. 2. Early Baart, white Australian variety. 3. Little Club, white. (U. S. D. A.)

only allows the soil to settle well but also conserves moisture and germinates weed seeds.

Implements for Preparation.—If sod is tough it should be turned over in preparing wheat fields. Plowing with a long moldboard is probably best, but if wheat stubble is being turned, it is better to use a plow with a steep moldboard. This crumbles the soil as it bends the furrow-slice.

Disk harrows with solid disks are very satisfactory for pulverizing plowed ground for small grains. If the ground be cloddy,

for any reason, perhaps a plank drag or a rough roller should be used. An Acme harrow is a good clod crusher.

A smoothing harrow commonly called a spike-tooth harrow may be either solid or adjustable and in sections. For wheat it is well to turn the teeth backward so as to firm the soil beneath the surface. A harrow thus adjusted is a good clod crusher.

Grain drills are of several types: Shoe, hoe, and disk. Shoe drills were formerly common and did very satisfactory work, except when the soil contained much litter. Disk drills may work better in litter, and are most popular in many regions.

Covering devices attached to drills are of several kinds. Rings

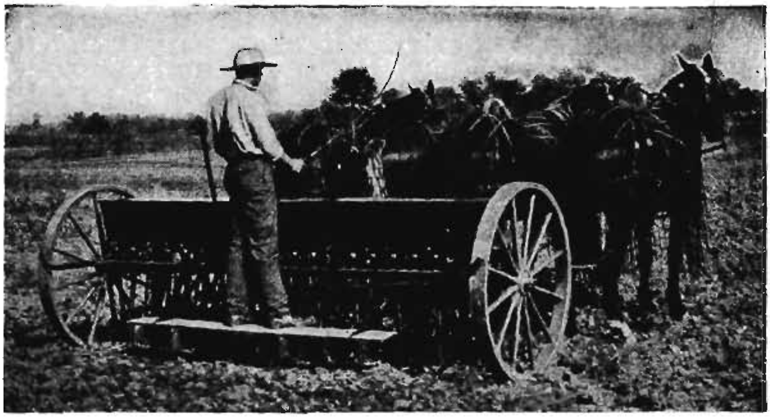


FIG. 59—A wide grain drill is well adapted to large farms in the grain belt. (I. H. Co.)

or chains are popular because of leaving a dust mulch over the rows of grain. Wheels to press the soil over the grain aid in bringing capillary moisture to start germination. If a chain drags behind the wheels the moisture is less likely to evaporate.

Close attention must be given to the feeding box and feeding tubes to see that grain is supplied through all of them constantly.

A fertilizer box on a grain drill saves much extra work if commercial fertilizer is used. This is the most economical way of supplying the fertilizer. If clover or grass seeds are to be sown when the grain is planted, a grass-seeding device and box should be attached to the grain drill.

Planting Wheat.—The best methods of planting wheat are with grain drills. (Fig. 59.) The distances between rows is commonly seven inches.

Broadcasting wheat is rather wasteful of seed and does not

supply so even a stand. Much of the grain is not well covered and may be picked up by sparrows and other birds. Where little wheat is grown broadcasting may be more economical. Harrowing should follow immediately after sowing to cover the seed promptly.

Depth of Seeding.—Where drills are used the depth can be governed. It varies with the surface conditions of the soil, from one to two inches. If soils are heavy or damp one inch is enough. Quick germination is desirable.

Amount of Seed to Use.—Three to six pecks of seed are

FIG. 60.—A, cleaned seed wheat. B, shriveled kernels affected with scab disease. (U. S. D. A.)

usually sown to an acre, more being used in rich soil than in poor soil, and more for spring grain than for winter grain. An average bushel of good wheat seed should produce about twenty plants to each square foot. Winter wheat tillers more than spring wheat and some varieties tiller more than others.

Securing Clean Seed.—Seed wheat should be screened and fanned until it is not only clean but until the heaviest and plumpest seeds are separated from the shrivelled and small kernels. (Fig. 60.) Use only the best for seed. Several screenings will probably remove all weed seeds, even corncockle. Plump seeds sprout better and supply the young plants with their first nourishment. Young wheat has to withstand many adverse conditions and should be given every advantage possible.

If a fanning mill is not owned by the farmer he should take his seed wheat to where there is one. It should never be planted directly from the ordinary thrashing machine.

Treating Seed for Smut.—Several forms of smut diseases attack small grains. (Fig. 61.) As these diseases do not live in the soil but are transmitted by spores adhering to the seeds. it is important to destroy these spores by treating seeds with materials to destroy them, and not hurt the grain. Treat seeds in 1 pint semesan with 50 gallons water for 30 minutes.

Another effectual and inexpensive method is to soak the seeds for about ten minutes in a solution of formaldehyde. Mix one pint of full strength or 40 per cent formaldehyde in forty gallons of water. Sprinkle this over the mass of seeds while it is being stirred, until all seeds are wet. A more certain plan is to immerse the sacks of seeds in a tank or barrel containing the solution. Leave them there until wet through. Then drain for a few minutes and empty the grain on a clean floor to dry. Cover with sacks to hold the fumes for an hour. If the wet grain is spread well and stirred several times it will be dry enough to sow in a few hours. For hidden smut heat the solution to 122 degrees F. and immerse the seed for 2 minutes.

FIG. 61.—Grain smut disease reduces the yield as shown on oats at the left.

Time of Seeding.—Spring grain should be sown as early as conditions of the soil will allow. As this is mainly a northern crop the time will vary according to the season. After all frost is out of the soil and when the surplus moisture has left the surface in a condition to crumble nicely when harrowed, preparation and seeding should begin and should be pushed until completed.

Winter wheat is sown in rather late fall or after danger of attack by the Hessian fly has passed. It is desirable to secure a good growth and some tillering of the young crop before winter weather begins unless the Hessian fly has been serious in the region. Weather and climate are the chief points to consider in deciding

when to sow the grain. In the drier regions there may not be enough moisture for germination. It may be necessary to delay seeding until there is enough moisture in the soil to promptly sprout the grain.

Dry Farming Conditions.—Wheat is a crop well suited to growth where dry farming is practised, as it makes much of its growth during the moist seasons of the year.

In preparing for wheat, plowing should be very deep if rains are likely to occur. This forms a deep "reservoir" for holding surplus moisture.

Subsurface packing of the soil begins very soon after plowing to induce capillary rise of moisture to the seed bed.

To allow soil to settle, a season of bare-fallow before planting is advisable. A fine soil mulch is maintained throughout this period which prevents weed growth.

Winter wheat stands are blown out by wind during seasons when little snow covers the soil. To prevent much of this damage, the surface should be left in ridges. This may be produced by the use of disk drills or by disking the ground before broadcasting by alternate disks removed from the machine.

Harrowing After Seeding.—Where fall grain is sown by some broadcasting method and where winter winds are not likely to blow out the crop, the surface should be left smooth by harrowing after seeding. Good drills usually leave the surface in a condition which does not require harrowing after seeding. The extra labor is usually not justified.

Pasturing Young Grain.—Tillering of winter grain during the fall growth is very beneficial. It induces a better stand and yield, protects somewhat from winter injury and helps reduce damage from the Hessian fly. To induce tillering of winter wheat, farmers in districts where this crop is grown often pasture the fields after the wheat is up a few inches. This should not be done until very late fall, winter or early spring, depending upon the amount of growth up to that time. Care must be exercised not to allow livestock to tramp the soil when muddy.

Such pasturing is usually very beneficial to livestock and much succulent feed may be thus supplied with no added expense. It is particularly valuable for dairy cows.

Harrowing Young Grain.—It is sometimes advisable to harrow young grain after it is about ready to form stems. This will encourage tillering. Winter grain is sometimes harrowed in the spring with much increases in yields.

Rolling Wheat.—After planting, wheat fields should never be rolled with a smooth roller unless a harrow is to follow it. A smooth roller leaves a surface which may bake and crack or a crust will form. Moisture evaporates rapidly after the use of a smooth roller, thus robbing the crop of necessary moisture. Rolling soil before or after planting is often advisable to aid germination. A rough roller should be used for this.

If winter wheat has been heaved out of the ground somewhat by winter freezing and thawing, a roller will aid greatly in replanting or pressing it back into the soil. Such rolling should be done as early in the spring as possible.

Studying Young Grain.—Every wheat grower should examine his wheat crop at different times during the growing season. Watch for any unhealthy appearance of the young plants such as sickly color, poor growth, rusty leaves, or scab disease. Heaving, winter killing, spindley stems, starvation, weeds, insects and other troubles should be detected promptly. Try in all cases to detect any unfavorable conditions which may cause any of these. Always try to make conditions favorable for the crop. It may be within the power of the grower at times to apply a suitable remedy for the difficulty, such as stimulating growth by top dressings with fertilizers or lime, pasturing, harvesting, rolling, mowing, reseeding, and spraying.

Call an expert or good wheat grower who may be familiar with the troubles and suitable remedies.

The Hessian Fly.—This is by far the worst insect attacking growing wheat. It seldom attacks other small grain crops seriously. It is far more injurious in the central latitudes of the eastern half of the United States than elsewhere. Here it sometimes destroys one-fourth or one-half the entire crop. An average of 10 per cent of the whole crop of the country is taken by this insect.

The adults are small gnats with two wings. (Fig. 62.) The females lay one to two hundred eggs in rows on the upper surface of leaves of young growing wheat during warm fall days. Reddish maggots hatch from these eggs. They soon turn white. These burrow beneath the sheath usually causing a slight enlargement at the point affected. This may cause the plant to branch more and will cause the farmer no alarm, but later he may see that the plants turn yellow and dry. The maggots live in the stems or soft interior parts of the bud, absorbing the sap from the tissues. In the spring multiplication is rapid. Stems of wheat break and fall before ripening and cannot be harvested.

Mention has been made of the best method of preventing damage from Hessian fly—late planting. If females have laid their eggs on grasses and other plants and have disappeared by winter, the wheat crop is protected. Rotation of crops will help, as the flies cannot travel far unless conditions are favorable. Plowing under the stubble promptly after harvest also destroys many of the insects. No voluntary grain should remain in the field between harvest and seed time. This should either be plowed up, pastured or otherwise destroyed. Varieties with coarse, strong straw are

FIG. 62.—Hessian-fly galls on wheat stem, *h*, and healthy wheat at left. *a*, egg; *b*, larva; *c*, "flaxseed" or winter stage of larva; *d*, pupa; *f*, adult female; *g*, adult male; *i*, the parasite which often destroys the Hessian-fly or holds it in check. (Economic Entomology.)

recommended. Wheat grown on rich soils with plenty of fertilizer is less seriously affected.

Wheat Smuts.—These are of fungous origin and their attacks cause heavy losses. Smut plants start when the wheat germinates, growing within the wheat plant until heads are formed. The masses of spores are seen in the head where the kernels of grain should be. Loose smut is more easily detected than stinking or hidden smut. The latter produces a smut ball in place of each kernel of wheat. Methods of treating the seed to prevent attacks of smut have been described. The formaldehyde treatment there described is very successful in controlling stinking smut. As loose smut is often enclosed in the kernels of seed wheat, a treatment with hot water has been devised. Wheat is first soaked three or four hours in cold water, next it is immersed in water at 129 or 130 degrees F. It is difficult to keep the temperature just right. Hold it at this temperature for ten minutes. Too much heat will kill the seeds and too little will not kill the smut spores.

Grain rust is a disease affecting the leaves, stems and heads of the small grain crops. Yields are greatly reduced when the attacks come early. The fungus which causes the trouble spends one generation in its life cycle on the common barberry plant. Destruction of this host is, therefore, a good means of preventing the grain rust. (Fig. 63.)

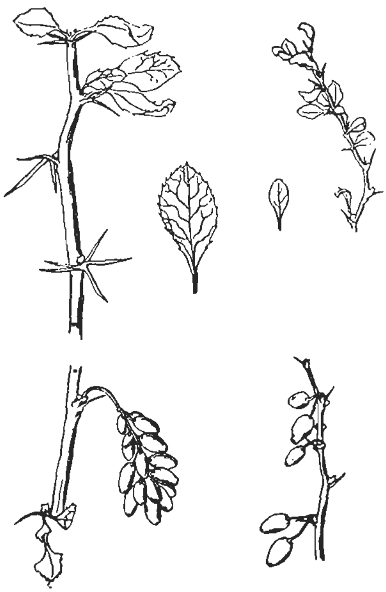


FIG. 63.—Left, stem, leaf and fruit of common barberry; destroy it. Right, stem, leaf and fruit of Japanese barberry; save it.

Hay from Cereals.—Small grains, if cut in the milk stage of the grain or a little earlier, may be readily cured and produce good yields of palatable hay. If mixed with legume crops such hay is much improved. If it is intended to cut the crop for hay it is a good plan to sow with the seed about one bushel of Canada peas or one-half bushel of vetch per acre. With spring grain use spring vetch or Canada peas. With winter grains use winter vetch.

Curing Cereal Hay.—Curing such mixtures differs only slightly from curing hay made from common grasses. It is usually left in the swath longer after mowing. Most of the curing can be in the swath and windrow, therefore shocking may not be necessary.

Farmers sometimes make hay from grain fields for some special reason, such as low prices of grain, weedy fields, poor stands, smut or rust.

Harvesting Grain.—Common harvesters or self-binders (Fig. 64) are almost invariably used where wheat is grown. Even in foreign countries American-made machines for this purpose are being introduced. The most modern grain binders may have carrier attachments and drop enough bundles in a place to form one shock. Harvesting should take place before there is danger of shelling during the cutting process. Herein lies some danger. A day or two of extremely hot sun or wind may cause much grain to be lost during harvest time. Avoid cutting when the grain is in the dough stage. It should be hardened a little before cutting. The color of the heads and stems may be used as a guide.

Headers are machines which clip the tops of the stems and

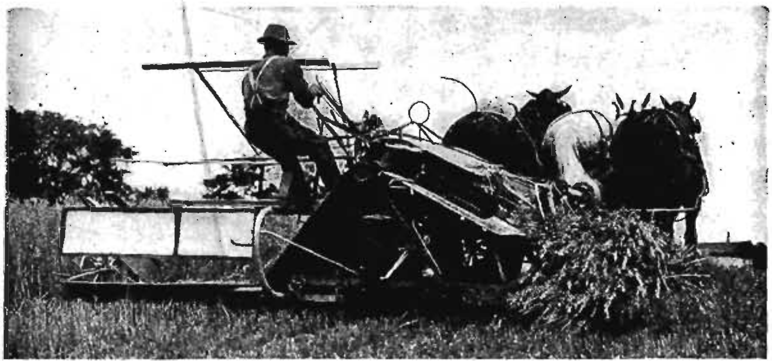


Fig. 64.—Harvesting grain with a self-binder. (I. H. Co.)

carry the heads over into a specially constructed wagon box driven alongside the header. Such machines are used in the drier regions where curing in stacks or in shocks is unnecessary. The heads are either piled until thrashing time or are fed directly into a thrasher from the wagon box.

Combined harvesters and thrashers are sometimes used on the Pacific coast and in some other dry regions.

Shocking Wheat.—In all except the drier regions of the wheat-growing states wheat is put in shocks after cutting with binders. A man, in shocking wheat, has to use some skill in standing the bundles so they will lean toward the centre and not be blown over. The capsheaf serves two purposes, to bind the shock together and shed off rainfall.

Wheat that has been cut before the straw is dead ripe must cure longer in the shock than wheat that is more mature.

Many farmers thrash from the shock, *i.e.*, the bundles are

hauled on wagons to the thrasher, enough wagons being used to keep the thrasher running.

Stacking or Not Stacking.—In some sections it is considerably better to stack the bundles after they have cured in shock for a few weeks. Small stacks are arranged conveniently so that when thrashing begins little or no hauling by wagons will be necessary. This plan saves the straw better. (*Fig.* 65.) It saves employing so many teams and men at thrashing time. It holds the grain until prices have recovered from the drop of harvest time. The chief objection to this plan is that extra labor is involved. sometimes it is difficult to secure thrashing machines in late fall or winter. Blackbirds and sparrows sometimes make serious raids

FIG. 65- Straw is burned by some farmers, while others make good use of it for feed, bedding and manure.

upon stacks of grain, but any damage from this source is usually due to poor methods of stacking. If the butts of straw are turned outward, loss from birds and exposure to weather is avoided.

Thrashing and Thrashers.—The period when grain thrashing is being done is considered a strenuous time on the farm. Usually neighbors are engaged to help. The household is often required to furnish meals and if weather be rainy shelter must be found for extra men and teams.

Large thrashers (Fig. 66) are preferable to small ones as the work is finished more quickly. Small machines are tedious and slow and often keep the men waiting. Probably in nine-tenths of the grain-growing sections the thrashers are owned by one man or small groups of men who operate them, going from farm to farm as needed. Usually they are operated only during late sum-

mer and fall. Only a few farmers have their individual thrashers and these are of a size to suit their needs. Because of the expense small machines are likely to be used under the individual ownership plan.

Yields of Wheat.—The average yields of wheat including both winter and spring crops is approximately fourteen bushels per acre. Small producing states often give heavy yields per acre. Nevada averages twice the country's average. Washington state holds the highest average of the ten leading wheat states. In favorable years and under good conditions wheat frequently yields thirty bushels per acre in any region.

Storing Grain.—If the market price of grain is low at thrash-

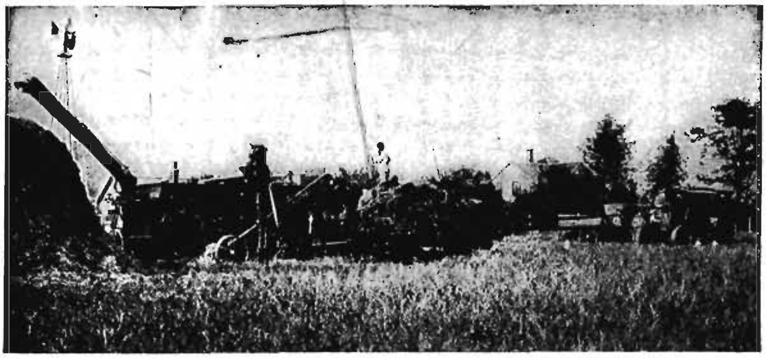


FIG. 66.—The modern grain thrasher removes the grain from the straw, and fans out the dust and chaff. The straw is usually blown through a pipe to the stack. (I. H. Co.)

ing time and there are prospects for better prices, farmers often store thrashed grain in home granaries or in community warehouses or local elevators. In such places it can be safely held until prices are more favorable. It should be kept free from attacks of grain moths and rodents.

Recleaning Grain.—Small grain coming from thrashing machines is often so foul that it needs recleaning. Sifting and fanning in the recleaning process will remove grains affected with hidden smut, other shrivelled and broken grains, weed seeds, particles of stems, gravel and other foreign matter. The cost of cleaning grain is usually more than balanced by the increase in grade of wheat which brings a better price.

Use of Screenings.—Materials screened from wheat and other small grains are of some value in feeding chickens and pigs. Screenings may be fed either raw or cooked, ground or whole, wet or dry. The popular method is to grind and soak them for feeding pigs.

They are thus entirely consumed with no danger of spreading weeds on the farm. Wheat dealers commonly clean large quantities of wheat and grind the screenings for sale to farmers in mixed feeds.

Grades and Grading.—Every wheat grower should obtain the very best expert advice available and grade his own grains. Write to the Bureau of Markets for leaflets and bulletins describing the standards for different grades and regulations governing the sale of wheat after sampling and grading. Official grading of wheat before selling often saves the farmer from becoming the victim of unscrupulous dealers. (Fig. 67.)

Grade requirements for the five leading grades of market wheats.

Grade No.	Minimum test weight per bushel.			Maximum limits of— Moisture.		Damaged kernels.		Foreign material other than dockage.		Wheats of other classes.	
	White, Durum, Hard and Soft Red Winter.	Hard Red Spring.	Red Walla Winter.	Hard Red Spring, Durum.	Hard and Soft Red Winter, and White.	Total.	Heat damage.	Total.	Matter other than cereal grains.	Total.	Durum.
	Lbs.	*Lbs.*	*Lbs.*		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1.......	60	58	58	14.0	13.5	2	0.1	1	0.5	5	2
2.......	58	57	56	14.5	14.0	4	0.2	2	1.0	10	3
3.......	56	55	54	15.0	14.5	7	0.5	3	2.0	10	10
4.......	54	53	52	16.0	15.5	10	1.0	5	3.0	10	10
5.......	51	50	49	16.0	15.5	15	3.0	7	5.0	10	10

The wheat in grade No. 1 shall be bright.
The wheat in grades Nos. 1 to 4, inclusive, shall be cool and sweet.
The wheat in grade No. 5 shall be cool, but may be musty or slightly sour.
A *sample* grade is established below 5 in each type of wheat usually sold by samples.

Optional Studies.—*Wheat Breeding.*—Experiment stations, in the leading wheat states, are constantly striving to improve the crop by selection or crossing. The United States Department of Agriculture has done much toward the improvement of wheat growing in America by introducing new types or varieties for growth here. Durum wheat was thus introduced rather recently. This wheat is chiefly used for production of macaroni and in pastry baking. Its introduction extended the wheat belt further into semi-arid regions. As wheat is naturally self-pollinated, it does not cross in fields. Varieties when once established are easily kept pure. The result is that we have many well-established varieties.

History and Production.—Look up the earliest production of wheat

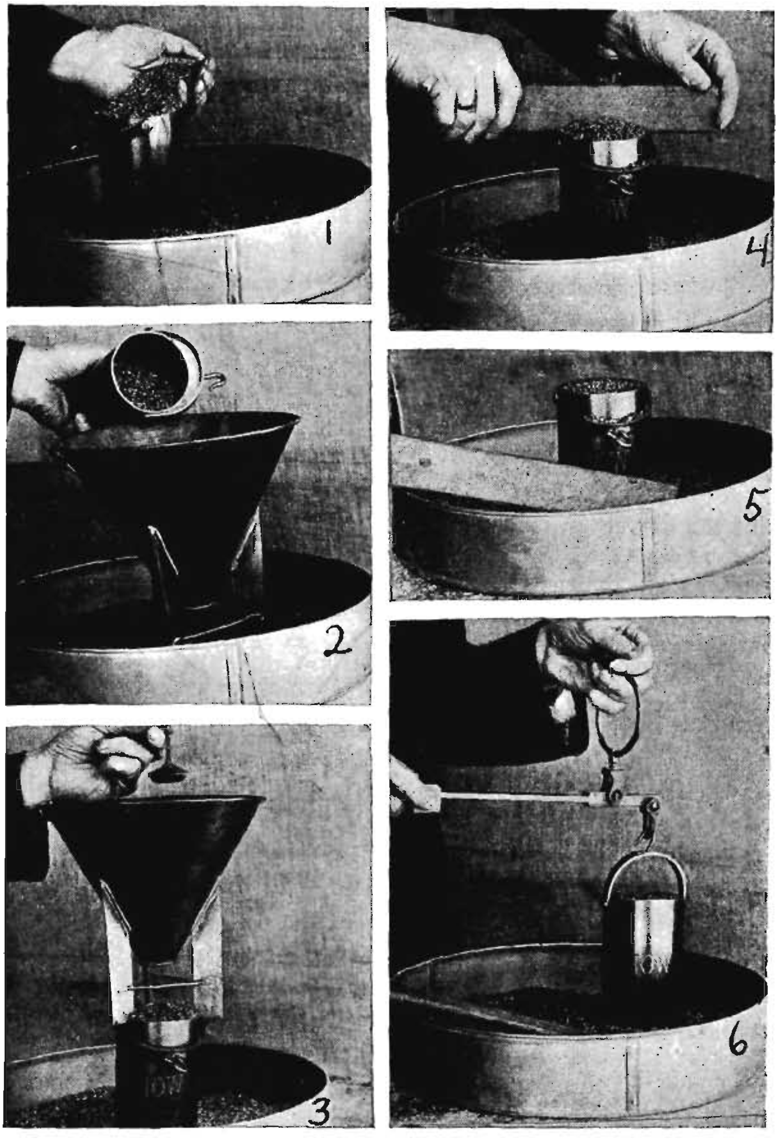


FIG. 67.—Steps in making test weight of wheat with scale and test kettle. 1. Heaping the test kettle for transfer to funnel. 2. Emptying into funnel. 3. Plug released and grain run into test kettle. 4. Stroking. 5. Ready for weighing. 6. Making the reading when scale is balanced. (North Dakota ...

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and study the early methods of seeding, harvesting, thrashing, and grinding. In the Yearbook (U. S. D. A.) for 1921 compare the continents in wheat production; also make a list of the ten leading states in order of wheat production. Compare the farmers' income from wheat with those from corn, hay, and cotton.

Oat Projects

The oat crop is very important in America. More bushels of oats are produced than of wheat, but the weight is much less as the legal weight of oats is usually thirty-two pounds per bushel, while wheat is sixty pounds per bushel.

Soils for Growing Oats.—Oats are often produced fairly well upon soil that is too poor for the profitable growth of wheat. The crop will thrive best on much richer soils than this. Heavy soils suited to good hay crops are among the best for oats. Large yields are produced when good applications of fertilizer are made. Too much nitrogen, however, tends to cause the grain to lodge, or too much straw and too little grain may be the result.

Types and Varieties.—Practically all of the oats grown in this country are of the hulled type. Hulless oats are grown somewhat in Canada and the northern tier of states. In this type the grain separates from the hull during the thrashing process. As breakfast food factories need to remove the hulls, the hulless type has increased in popularity.

The varieties of common oats are grouped in two types according to the shape of the panicles: (a) Spreading; (b) side oats or "horse-mane" oats. (Fig. 68.) The latter is far less common. There are many varieties of spreading or "sprangled" oats.

The seed of oats varies in size, color and shape. The chief colors are white, yellow, black, and red. Gray oats are usually classed with the black, and brown oats with the red. White varieties are more popular in the northern regions, while red and gray are common in southern regions. Early varieties may mature in ninety days from seeding and late varieties may require 130 days. Others vary within these limits.

Winter varieties of oats have been produced and are used in southern states and somewhat on the Pacific slope. In other sections spring oats are grown.

Choosing the Type and Variety.—The variety to grow should be determined by inquiry regarding the success of varieties that have been tried locally. Ask farmers who have tried them. Talk with the county agent and write to the state experiment station. Yield depends much upon the variety as well as upon seed, soil, and methods. Investigate varieties before selecting seed.

Preparation for Oats.—As the seed bed for oats should be well packed before seeding, the plowing should take place, if possible, several weeks before seed time. This will allow the soil to settle. Otherwise use a rough roller or plank drag to somewhat firm the

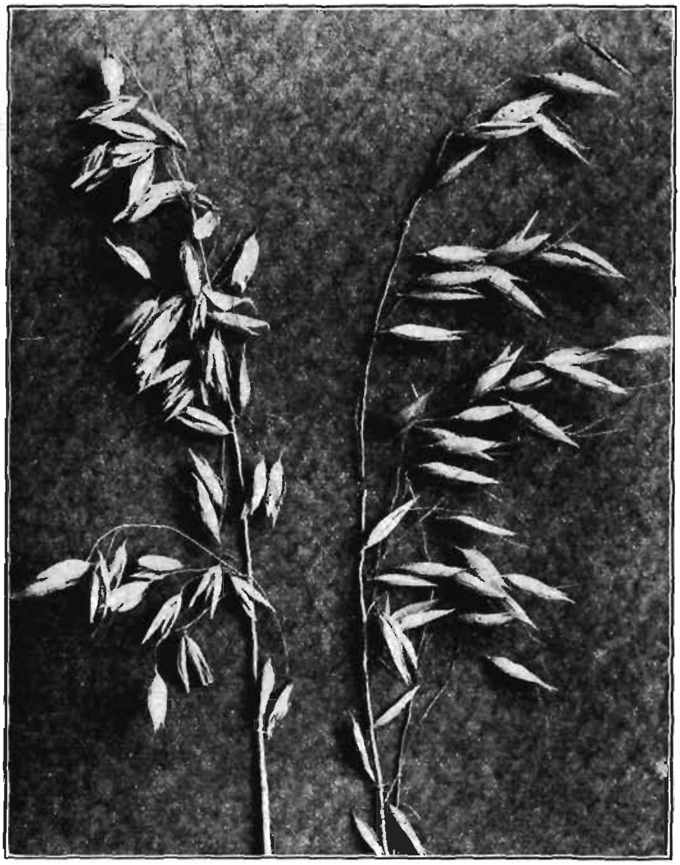


FIG. 68.—Two types of oats. At left, panicle or spreading oats; at right, side oats. (Wyoming Station.)

soil. Good plowing and harrowing are advisable before the crop is sown, but in some sections the soil is double-disked instead of plowed. The disking method may be followed with satisfactory results if the preceding crop, as corn or potatoes, had clean culture.

Treatment of Seed.—If oats are subject to smut disease the seed should always be treated with semesan or formaldehyde, as for wheat, before sowing.

Select good seed weighing, if possible, as heavy as thirty-eight or forty pounds per bushel. Light seed will produce poor results.

Seeding may be either broadcast or in drills. Drilling methods give better results and save seed. When broadcasting methods are used, the field should be harrowed or disked to cover the seed: covering to a depth of two or three inches is usually better than less, if the surface be loose. For winter oats, sow in the fall early enough to allow the crop to make considerable growth before winter in order to help protect it from winter killing.

Throughout the northern and central regions where spring oats are grown seeding should be done as early as the soil can be prepared.

The amount of seed per acre varies according to the methods of seeding, methods of covering, and thoroughness of preparation. Less than two bushels of seed is seldom sown except in dry farming areas where moisture must be conserved. Two or three bushels are common in both winter and spring oat regions. European farmers usually use much more than this.

Harrowing oats after some tillering has taken place is practised particularly in dry regions and in dry seasons elsewhere. This saves soil moisture.

Harvesting Oats.—Where binders are owned by farmers they are used in harvesting the crop. In a few regions of the Atlantic and southern states mowing and raking, as for hay, are often practised. In either method the grain should be cured in shocks until thoroughly dry. Otherwise the grain may discolor after thrashing.

Thrashing may be either from the shock or from the stack as already described for wheat. If oat straw is more valuable for feed than straw from the other small grains, the stacking of oats to save the straw is more common.

Storing.—As oats are so commonly used for feed for horses and other livestock, facilities for storing in bins or granaries on the farms where grown are commonly found. Bins should be located handily for feeding. Where grain moths are serious as in central and southern regions the bins should be rather tight and the grain should be treated with carbon bisulfid.

Marketing.—Oats are graded into four commercial grades, shown in the table. In white oats the "standard" grade is made between Nos. 2 and 3 because so much of the crop falls in either standard or below. Prices vary according to grade. White oats bring better prices than the other colors.

Grade requirements for white, red, gray, black, mixed, bleached, and clipped oats.

Grade.	Condition and general appearance.	Minimum test weight per bushel.	Sound cultivated oats not less than	Heat damaged (oats or other grains). Not to exceed—	Foreign material. Not to exceed—	Wild oats. Not to exceed—	Other colors, cultivated and wild oats. Not to exceed—
		Lbs.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1	Shall be cool and sweet, and of good color........	32	98	0.1	2	2	2
2	Shall be cool and sweet, and may be slightly stained..	29	95	0.3	2	3	5
3	Shall be cool and sweet, and may be stained or slightly weathered	26	90	1.0	3	5	10
4	Shall be cool, and may be musty, weathered, or badly stained...........	23	80	6.0	5	10	10

Clipped oats weigh about three or four more pounds to the bushel than unclipped oats. Weight is an important factor in grading the crop. Freedom from cheat or chess greatly increases the grade.

Uses of Oats.—Many farmers grow oats entirely for home use. They are fed whole to horses, they are soaked for pig feed and are ground with corn or other grains to feed to dairy cattle. As poultry feed they may be fed either whole, or clipped, or may be crushed to use in dry mash mixtures. In commerce millers grind them to be used in various mixtures of stock feeds. Breakfast foods for human consumption are made from the grains. The hulls, broken kernels and screenings are mixed with low grades of oats and other grains, and finely ground for livestock. (See Appendix table for feeding value.)

Optional Studies.—This crop was used in ancient Greece and has grown in popularity constantly since that time. The plant is believed to be a native of central and western Asia. Improved methods of cleaning and grinding have added greatly to the use of oats. The crop was introduced into America from Europe by the early colonists. It is much more common in cool climates than warm. We have close relatives of cultivated oats sometimes sown or found wild in fields and pastures. Besides the wild oats we find velvet grasses and tall meadow oats in grass mixtures.

The Barley Crop

This crop is the third in importance among the small grain cereals. In past years it has been extensively grown for use in brewing beer. The feeding value of barley still causes a very extensive growth of the crop in America.

Soils for Barley Growing.—Any well-drained loam which will produce a fair yield of corn is good for barley. Light soils and extremely heavy clays are not well suited to this purpose. In the

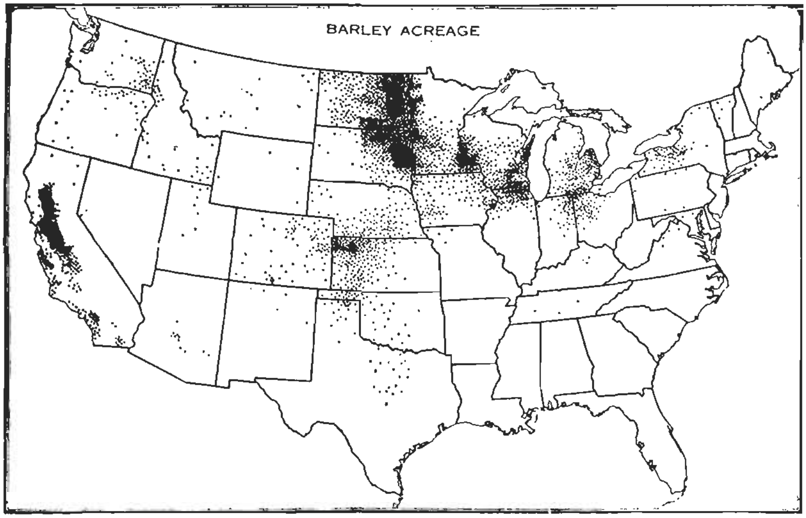


Fig. 69.—Distribution of the barley crop, each dot 2,000 acres. (U. S. D. A.)

alkali of some of the northwestern states this crop seems to thrive better than other cereals.

Fertilizers.—Well-rotted manure usually improves the barley crop. A surplus amount of nitrogen due to fertilization is apt to cause an extra growth of straw and may cause it to lodge. Organic matter in the form of green manure should be given time to decay before sowing the crop. When commercial fertilizers are used they may be applied at seeding time.

Regions for Barley Growing.—The leading barley states of the Union are in about the following order (Fig. 69): North Dakota, California, Minnesota, South Dakota, Wisconsin, Kansas, Michigan, Iowa, Nebraska. Each of these states had in 1919 from 200,000 to 1,000,000 acres. Like oats, this crop endures cool climates and when grown in the southern states is used as a winter crop. Elsewhere it is usually sown in the spring.

Choosing the Type and Variety.—Normally barley has six rows of grains on the rachis or stem. In some types the rows do not all pollinate. The result is two-row barley. A four-rowed effect is produced by a slight twisting of the spikelets when two rows only have pollinated. Some varieties of two-rowed barley have short, broad heads, and sometimes form a long, slender head. Again we have a classification of barley based upon the awns. Awnless barley makes better straw for livestock, as the awns or beards on the bearded varieties often injure digestive tracts of animals. Hooded barley is a name given to beardless varieties. Hulless varieties of barley greatly resemble wheat as the grain comes from the thrashing machine. (Fig. 70.)

Choose for your planting the variety which most nearly suits your local conditions. In the North it would probably be a two-row variety with long heads, either bearded or hooded. For winter growth in southern states be sure to select a variety which will withstand the winter, and if the straw is to be used for livestock, select a hooded rather than a bearded variety.

Inquire of local growers, county agents and experiment stations in deciding what named variety of barley to use.

Preparation of Soil for Barley.—For spring seeding fall plowing is important. For fall seeding plow the soil several weeks in advance. The soil should be thoroughly disked or harrowed just before sowing. As early spring seeding in the North is necessary the soil should be harrowed as early as possible. As with other small grains the lower soil should be well settled and the surface should be mellow and loose at seeding time.

Selecting and Treating Seed.—A given lot of barley seed may vary greatly in weight and size of kernels. This is particularly true of the six-rowed varieties. Fanning and cleaning will aid greatly in selecting the plumpest and best before seeding.

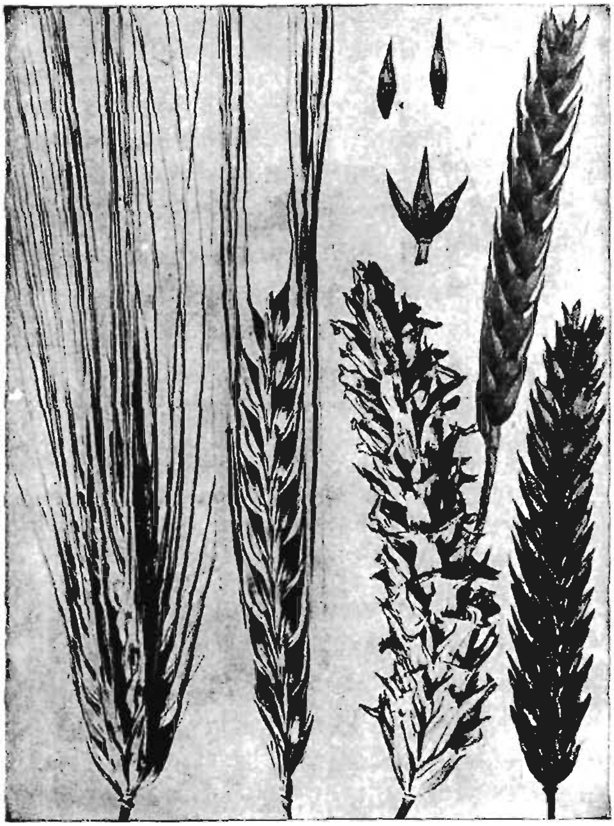
Use the hot water treatment or the formaldehyde treatment described for wheat to control the two forms of smut which also attack barley.

Sowing Barley.—As already stated, drilling is better than broadcasting, for all small grains, giving better yields and saving seed. For hull varieties use six to eight pecks per acre, except in semi-arid regions where one bushel may be sufficient. Four to six pecks of hulless barley per acre should give a good stand. Farmers sometimes use barley instead of oats for spring seeding, as barley can be seeded successfully a little later than oats. For winter barley the seeding should be done in September or October.

thus giving the young plants ample time to produce a good growth before winter.

Harvesting Barley.—The crop is harvested in much the same way as wheat. The market value depends much upon the stage

D



A B C

Fig. 70.—A. Six-rowed bearded (Black Hull-less). B. Two-rowed bearded. C. Six-rowed hooded (White Hull-less). D. A type of awnless winter barley, developed by H. B. Derr, while in the U. S. Department of Agriculture.

in which it is harvested. Much care must be exercised to avoid discoloration of hulled varieties by exposure to damp weather or from harvesting in immature condition. It should be at least in the hard dough stage. But if it is allowed to stand too long much may be lost from shelling during harvest.

Thrashing.—As already suggested, discoloration is likely to

occur after cutting and before thrashing. For this reason it should not be left long in the shock. Either thrash the crop early or stack it and thrash later from the stack. At thrashing time sort the bundles carefully, leaving the discolored ones until the last, so the grain will not be mixed and the quality of the grain can be maintained. In dry regions it is not risky to plan to thrash from the shock. Operators of thrashers in barley-growing regions become skilful in avoiding the cracking of kernels and in operating the separator to entirely remove trash and dirt.

Storage of Barley.—It is a common practice in barley-growing regions to leave the grain exposed to air on a large floor or canvas for a brief period before it is stored in tight bins. Shovelling it over will aid in drying it before storage.

Market Grades of Barley.—Crops intended for grinding at home for stock feeds are not graded. For market purposes eight grades are established, Nos. 1, 2, 3, 4, 5, 6, "No. 1 feed," and "rejected." No. 1 being the best, weighs forty-eight pounds to the measured bushel, when not clipped, is free from other grain, clean, sound, plump and bright. Variations in grade depend upon weight, color, uniformity, brightness, odor and germination. Foreign market demands materially influence the market grades. A good percentage of the barley marketed is exported.

Optional Studies.—Barley belongs to the Genus Hordeum. Its cultivation was noted in early Bible times. Egyptian tombs bear evidence of its use there. From West Asia its use spread across Europe to America. Dark flour and "black" bread, used by people of Asia and Europe, is often made from barley.

Barley is used in various countries of the world for flour, breakfast foods, malting purposes and stock feeds. The straw and hay from the plant are both used for livestock. Green fields are often pastured with benefit both to the crop and animals.

Rye Growing

This crop may be grown throughout the wheat-growing regions, but as a grain crop it is found most extensively in Pennsylvania, Wisconsin, Michigan, Minnesota, New York, Nebraska, New Jersey and Illinois.

Soils.—Rye will endure poorer soils than oats. For this reason it is not infrequently grown where other crops fail. When so grown it may be turned under as green manure to improve poor soils. As it thus increases the organic matter and available plant food, other and better crops are grown. For good yields of rye grain, good soils are preferred.

The soil is prepared for seeding in much the same way as

for wheat, but it is more frequently seeded on disked soil without plowing.

Seeding.—Rye is much more extensively grown as a winter crop than as a spring crop. Five or six pecks to the acre are used for drilling. Eight pecks should be used if sown broadcast.

Rye as a cover crop is a good soil holder and should be seeded early in the fall to make a good growth before winter. It may be turned under the following spring or left as a grain crop. When green manure is desired a mixture of winter vetch or crimson clover (for southern regions) will add greatly to the fertilizing value.

Pasturing Rye.—As suggested in the discussion of wheat, small grains may be pastured during favorable weather without injury to the growing crop. Rye will endure more of this than other small grains and produces good pasture for winter and spring grazing. Livestock should be removed from it as soon as the crop begins to form stems.

Ergot Disease.—Mature heads of rye often show dark spore masses of ergot disease. This not only reduces the yield of grain but its presence renders the grain dangerous for feeding to livestock, as breeding animals may be caused to abort their young. No preventive measures will entirely control ergot disease. Thorough cleaning of seed and rotation of crops both aid somewhat.

Harvesting and Thrashing.—When rye is grown as a grain crop, harvesting and thrashing methods are similar to those used for wheat. The crop may be readily stored and sold when the market price is best, or may be saved for future seeding.

Uses of Grain.—Some rye flour is made for human use in America. More of it is used for flour and bread in northern and central Europe. The grain was formerly more used for making alcohol and liquors. When free from ergot it is used for feeding livestock, particularly when ground and mixed with other grains. Much of the grain is sold for seed to be sown for cover crops.

Optional Studies.—This crop probably originated in western Asia and its use in agriculture dates back to medieval times.

Rye naturally cross-pollinates and different varieties of rye mix readily. For this reason new varieties when grown near others do not remain distinct for any length of time. In this respect it differs from other small grains. To keep a variety of rye distinct care must be exercised to grow it separately from others.

RICE GROWING

Rice is an annual plant of the grass family and is one of the leading small grains of the world. Wild relatives of cultivated rice are extensively eaten by ducks and geese in low lands from the Gulf to the Great Lakes.

Soils for Rice.—Lowland rice uses soils which hold moisture well and which are level and readily fertilized. An abundant supply of water for irrigation must be available.

Rice-growing Regions.—*Louisiana*, Texas, Arkansas, and California at present produce nearly all the rice grown in the United States. South Carolina and Georgia should be mentioned. The level plains and rich river bottom lands of these states are ideal for the crop. (Fig. 138.)

Preparation for Rice.—Plowing, harrowing and other soil preparations are similar to those used for wheat. The crop is almost invariably grown as a spring crop.

Applying water is accomplished either by damming the streams and diverting the flow to fields or by pumping. The fields are surrounded by low banks thrown up with plows or scarpers to hold flood water. Wells and gasoline pumps are conveniently located to pump the water directly on the rice fields. Three or four fields may meet at one corner where the well and pump are located. This plan makes it possible to grow rice on any one or two of the fields as desired. Thus a rotation of crops is readily managed.

Seeding Rice.—After the soil is well prepared seed is drilled as is wheat. The amount of seed used varies from one to two bushels per acre, depending somewhat upon the cost of seed and condition of soil. Most of the seeding is done in these states in April and May.

Watering.—Whether watering be by pumping or by stream flow, it is usually applied to the rice fields after the growth has attained a height of about six to ten inches. The flow must be controlled (Fig. 71) to avoid washing out of roots. An even depth of four or five inches of water over the field is ideal for lowland rice. For upland rice less water is used. Ditches near the bordering levees of the fields will aid in controlling the water flow. The water is kept over the field until the grain is well formed in heads. Then it must be drained off in time to allow the soil to become firm enough for using harvesters.

Harvesting Rice.—Rice is cut and bound into bundles with self-binders such as are used for other small grains. Shocking, stacking, and thrashing are similar operations to those used for wheat. Yields vary from twenty to forty bushels of rice grain per acre. Where seed beds are well prepared and all the conditions are most favorable one hundred bushels have been produced. The rough rice as it comes from thrashing machines is put through several milling processes in mills especially adapted for the pur-

pose: (1) Screening to remove trash; (2) removal of hulls; (3) separation of chaff from broken kernels; (4) removal of cuticle or coverings of kernels; (5) separation of this and the flour dust from the clean rice; (6) cooling; (7) removal of small or broken rice; (8) polishing; (9) grading. The main products and the by-products are then put in barrels or sacks ready for shipment to market.

Enemies of Rice.—Smut attacks rice and may be prevented by the hot water treatment or the formaldehyde treatment. Rice blast is a disease which causes the stems to break at the nodes. As the trouble occurs near the surface of the water, growers some-

FIG. 71.—First flooding of a new rice field after seeding. Difference in elevation between contours is about three inches. (California Station.)

times deepen the flood as they see the disease appear. If the attack comes late the water is drained away instead.

Insects are fairly well kept in control if flooding is properly managed. Alternate flooding and draining of fields is very effective against weeds and insects.

Weeds are not only controlled by flooding and draining but also in managing the fields between crops. Weed seeds may be thoroughly germinated and killed, leaving the soils clean for the next crop.

Optional Studies.—Rice is probably native of China where it has been cultivated for thousands of years. It has also long been grown in England, Egypt, and southern Europe. In 1694 rice was introduced to the United States at Charleston.

Prior to 1880 South Carolina and Georgia produced practically all of the American crop. At that time Japanese rice growing in Louisiana and adjoining states was extensively started through the efforts of S. A. Knapp and his co-workers.

Hundreds of millions of people in India, China, Japan and adjacent countries use rice as their main article of diet. Probably two hundred *billion pounds of cleaned rice produced annually makes the crop comparable* and really equal to the world's wheat crop. Those countries of Asia are still the chief producers.

Buckwheat Growing

New York and Pennsylvania are the leading states in the production of buckwheat, producing three times the crop of all other states combined. (Fig. 75.) Other important states in producing buckwheat are Maine, Vermont, West Virginia, and Virginia. The total annual crop in the United States is usually less than twenty million bushels.

A crop may be sown late in spring or early summer and must ripen before frost. It does not endure hot summers of the South.

It is often grown as a catch crop or emergency crop when other crops have failed.

Virgin soils or rich, deep, black loams are well suited to the growth of buckwheat, which crowds out weeds well at a season when weeds are otherwise thrifty.

Prepare the land well by plowing, disking, and harrowing. Plan to have a bare-fallow precede the sowing.

Seeding in May or June should allow the main crop to mature in the chief buckwheat states. Use three or four pecks of seed per acre. Broadcasting is common, but drilling is better. Harrow after broadcasting.

The crop usually has no serious enemies.

Each plant of the field continues to blossom and produce seed until the time of killing frosts.

Harvesting.—Cutting is usually delayed until frost has killed the leaves and blossoms. It should then be done as promptly as conditions will permit. Use a self rake reaper or binder. The binder may be run with or without tying. The danger of binding in bundles is that molding is likely to take place, due to moisture in the stems. Shocks must be made small or the bundles may be placed in long rows to hasten the curing. Thrashing is usually from the shock rather than from the stack.

The grain may be either sold from the thrasher or placed in bins for marketing at later dates.

Uses.—Buckwheat flour is used in many households and the grain is crushed or ground for use in feeding livestock. Poultry feeds often contain much uncrushed buckwheat seed. The blossoms produce large quantities of nectar, from which bees make

rich, dark honey. Beekeepers sow buckwheat for continuous bee pasture.

Flax Growing

As this crop is grown both for the grain and for fiber its classification might be with grain crops or with fiber crops. Both uses are considered here.

Regions for Flax Growing.—North Dakota is by far the leading state in the production of flax, growing more than one-half of the American crop. Minnesota comes second and South Dakota third. All other states combined produce hardly one-seventh of the entire crop. Montana and Kansas are among these. (Fig. 138.)

Soils for Flax.—New lands are by far the best for flax growing. Soils continuously used for the crop become affected with "flax sickness," causing the crop to be very light. This trouble is caused by a fungous wilt, which may live in the soils and on the seeds. Avoid using soils where this disease has appeared.

The flax plant may be called a ravenous feeder and will unlock plant food from new soils readily. Soils should not be too heavy. Sandy loams are ideal where new soils are used. Fertilizers and manures are seldom applied.

Preparation of Soil.—It is best to shallow-break new lands in the fall and allow the land to lie unharrowed until early spring. Disk the field in early spring without turning up the turf. The Acme harrow will then pulverize the surface without exposing the grass for growth.

When old fields are used deep plowing and more thorough preparation are practised. If time has not been allowed for the resettling of the soil after plowing a rough roller is necessary to firm the seed bed.

Seeding Flax.—Flax seed should be recleaned and only the best grades used. More uniform growth is thus obtained. Treat the seed with formaldehyde solution as recommended for wheat. This is to kill spores of wilt fungus and avoid introducing the disease on new fields.

Ordinary grain drills may be adjusted for sowing flax seed. Press wheels on drills are valuable in covering the seed. The pressure helps bring moisture to the seeds for germination. Cover the seed only slightly. Use about three pecks to the acre when grain is to be the product. When the crop is grown for fiber the rate of seeding is seven or eight pecks per acre. This prevents the young plants from branching and better fiber is the result.

Seeding should be delayed until just after the last killing frosts of spring are over.

Harvesting Flax.—The flax is harvested in about ninety or one hundred days from germination. This usually comes in September before fall frosts kill the crop. For the grain crop grain binders are used. The bundles are placed in shocks and thrashing usually is done from the field. Stacking is not often practised.

If the product desired is flax fiber the crop must have been sown very thick to prevent branching growth and weeds. Any weeds in the field are very objectionable. Although some machines have been invented to harvest fiber flax, most of the crop is still

FIG. 72.—Flax hackles. Dressed or hackled flax is prepared by drawing the scutched fibre first over the coarse hackle, then over the finer ones, combing out shives and tangled fibres. (U. S. D. A.)

pulled by hand. The handfuls are gathered in small armfuls, the stems being laid straight. They are then either tied in bundles or laid in neat piles on the ground. If bundled, shocks are made for curing.

Flax Fiber.—This product is used in making linen thread and cloth. The coarser tow is used in making strong twine. Fiber buckets and tubs are made from the straw after thrashing grain flax.

Good flax fiber requires several important operations (Fig. 72): (1) After curing in shock, the seed is rubbed from the heads by holding the straw while the heads are rubbed between rollers; (2) retting, by spreading the straw thinly on the ground to weather a few weeks; (3) breaking or hackling, in which wooden mallets, rollers or other machines for binding and breaking the straw are used; (4) scutching, beating with paddles to remove bark, pith,

and wood from the fiber; (5) sorting fibers according to quality and length; (6) bundling or baling into bales of about two hundred pounds for shipment to linen factories.

Flax Grain.—Most of the flax grown in America is grown for the seed. The grades established by the Minnesota Board are as follows: (1) Northwestern No. 1, No. 2, and No Grade. The Board defines Northwestern No. 1 flax seed thus: "It should be mature, sound, dry, and sweet; it should be northern grown; the minimum quantity of field, stack, storage or other damaged seed should not exceed 12½ per cent; the minimum weight shall be fifty-one pounds to the measured bushel; commercially pure seed."

The chief use of flax seed is for making linseed oil. By the old process the oil is extracted by crushing the seed, heating to 165 degrees F., and pressing. By the new process the oil is removed after grinding and heating, by the use of gasoline. The oil cake and meal remaining are used in feeding livestock, being rich in protein. The oil is used in paints.

Practicums and Projects

1. **Local Grain Survey.**—Make a brief questionnaire to use in gathering data concerning methods used in growing small grains of the neighborhood. Include such points as the following: Types and varieties grown; methods of preparing soil; time between plowing and planting; date of planting; usual wheat rotation; efforts toward soil maintenance during the rotation; treatment of all seed grain; most serious enemies; loss from each; amount of pasturing of crop; stacking or thrashing from shock; cost of thrashing; items of cost in growing the crop; yields; time of marketing; and price per bushel.

2. **Problems from the Survey.**—Make tables from the results of the survey. From these tables calculate the money returns per acre of wheat; find the average cost of wheat production per acre; per bushel. Calculate the money losses for the neighborhood, or for the county based upon neighborhood losses due to the most serious enemies, as Hessian fly or smut.

3. **Grain Charts.**—See suggestions for chart making near the end of the corn chapter. Students should make some good wheat charts. Make cross-sections of a kernel of wheat (Fig. 73) showing the location of the germ, the surrounding starch, the protein layer and the layers of bran. Make a chart of good wheat rotations for the region. Make a chart comparing two important differences in wheat production as the yields from newly plowed ground and from well-settled ground; differences in cost of thrashing from shock or from stack.

4. **Grain Pictures.**—Get implement catalogues from a number of manufacturers. Arrange pictures from these and from other sources, on placards for use in studying grain production. Such pictures should be classified. One group may relate to soil preparation, another to harvesting and thrashing, another to storing and marketing. Methods in different countries may be shown.

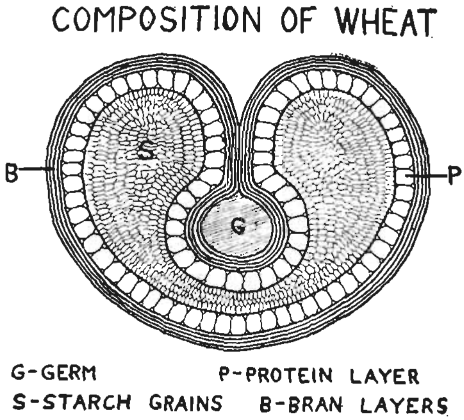
5. **Debates.**—Much interest may be aroused by debates arranged by the members of the classes. Suitable subjects can be made from the following topics: "It is more profitable to grow wheat than other products."

"Tractors are better than horses in grain farming." "Commercial fertilizers are more economical than green manure or barnyard manure." "Rotations with small grain." "Time and depth of plowing." "Dry-farming methods *vs.* other methods." "Thrashing from shock or from stack."

6. **Field Trips.**—In studying small grain production, classes can make trips to fields with much profit, studying various operations and methods being used at the time. At seeding time they may study methods of soil preparation, methods of planting, varieties sown, cleanliness of seed, fertilizer mixtures, operation of drills, and rotations in use. Several fields should be studied if time will allow. Going to and returning from the fields, students may debate some of the above topics or they may criticise or praise certain methods observed.

7. **Grain-growing projects** may be planned by students who are to pursue these projects on their own farms or on land secured for this purpose. Make the plans very full. The column method of planning is very easily followed. Place in the first column the various steps in grain growing, such as the headings for wheat in this chapter. In the second column write briefly the studies involved in each of the steps. The third column should be used for citations to reference books and bulletins.

8. **Trials with Projects.**—In growing small grains comparisons may be made of different methods on different parts of the area: Compare green manure with barnyard manure; compare deep plowing with shallow plowing; compare early plowing with late plowing; pasturing and no pasturing; liming and no liming; compare different fertilizer mixtures.



	PRO.	CHS.	FAT	FIBR.	MIN.
BRAN	15.4	62.9	4.0	9.0	5.8
SHORTS	16.9	62.4	5.1	6.2	4.4
RED DOG FLOUR	18.4	66.5	4.0	3.0	2.6

FIG. 73.—Such a wheat chart may be made on sign cloth with sign-writer's ink. A good size is three feet wide and four feet long.

9. **Collect grain samples** showing different types and varieties. If possible have them in head as well as thrashed. Members of the class can write to friends in distant regions for such samples. Samples may be exchanged. Get samples of products and by-products from milling companies, from cereal manufacturers and from feed mills. Collect a series of grades of one or more types of grain.

10. **Letters on Grain Growing.**—Members of the class may locate correspondents in other grain regions of the country or of the world. Write to them describing local operations and conditions regarding grain growing.

Invite correspondents to reciprocate by writing descriptions of conditions in their own regions or countries, to be read to the class.

11. **Exercises.**—Obtain large enough samples of grain to grade and have a number of exercises in grading. Plan other exercises: Mixing fertilizers; treating seed by the formaldehyde method and hot water

method; cleaning grain with fanning mill; compare heads and number of grains per head; treating stored grain with carbon bisulfid.

Questions and Investigations

1. How does your state rank in wheat production? Other small grains?
2. Give small grain rotations good for your state.
3. Describe the best soils of your region used for the different small grains.
4. Mention the varieties of each of the small grains grown in your region.
5. How are soils prepared in your region for oats? Wheat? Rye?
6. Tell how each is planted and rate of seeding.
7. Give sources of seed for small grains.
8. Describe the treatment for smut.
9. What harrowing or other tillage is given the growing crop locally? Pasturing?
10. What enemies attack small grain crops locally? How controlled?
11. Describe making small grain shocks.
12. Give reasons for thrashing from shock; for stacking.
13. Describe the local system of thrasher ownership and management.
14. How are small grains stored?
15. Describe a fanning mill and give its uses.
16. What grades of wheat or other small grains are produced locally for market?

Farm Mechanics.—Make drill stand (Fig. 59); seed treating devices; weighing devices; rat-proof grain storage bins. Repair drill; binder; rake; thresher; fanning mill.

Calculations.—1. By treating seed oats with formalin to prevent smut, a young farmer found by trial that he increased the yield 15 bu. per acre. The cost of treatment was 2¢ per acre besides the labor which he valued at 7¢. At the present local price of oats what was his net gain per acre? For 40 acres?

2. By cleaning wheat with a fanning mill a young farmer increased the price 10 per cent and used the cleanings for dairy feed which balanced the reduction in weight. He sold 1,100 bu. At the present price of No. 1 wheat what was his increased return due to cleaning?

3. If this young man had sold 250 bu. for seed wheat at double the present market price, and sold the balance as in problem 2, what would be his profit from cleaning, which cost 1½¢ per bu.?

4. A farmer with 60 acres of winter wheat grazed it with livestock in late fall and early spring, and found the stand was improved by tillering and the yield was 15 per cent greater. Find his total yield if ungrazed fields yielded 20 bu. per acre.

5. If the pasturage of livestock was valued as equal to the cost of seed and seeding (in problem 4), find the money value at local seed prices, allowing 6 pecks per acre.

SORGHUM AND MILLET ENTERPRISES

Analysis into Jobs.—The following jobs include the growing of sweet sorghums (sorgo), grain sorghums and millets. These are treated together because of natural relationship. References are made to pages in *New Agriculture*, Davis' *Farm Projects and Problems* and to *U. S. Farmers' Bulletins*. See *Field-Crop Enterprises* and *Southern Field-Crop Enterprises*.

1. **Deciding whether or not to grow one of these crops,** pp. 24, 25, 119, 126, 129; *Farm Projects*, 102, 104; *Bulletins*, 1511, 1619, 1631. *Local inquiry.*—(*a*) Farmers should be asked regarding the growing of these crops. (*b*) Suggest they compare sorghum with field corn for profit. (*c*) Let them compare millet with other summer crops such as cowpeas and soybeans.
2. **Choosing the crop and the variety,** pp. 119–120, 122–123, 129; *Farm Projects*, 104–108; *Bulletins*, 1034, 1158, 1162, 1511, 1574, 1597, 1619, 1631. *Local inquiry.*—(*a*) Which form of sorghum, grain or sweet, is most grown in your region? (*b*) Find the types and varieties which are most successful. (*c*) The county agent and leading farmers should be asked to discuss varieties.
3. **Selecting of seed in field,** pp. 31, 32, 120; *Farm Projects*, 108–109; *Bulletin*, 1175. *Local inquiry.*—(*a*) How are seeds of these crops procured—find all methods. (*b*) Ask growers to compare these methods with each other. (*c*) The best growers of each variety should be asked to show what points to consider in field selecting of seed.
4. **Selecting soil, field and acreage,** pp. 39, 123, 126; *Farm Projects*, 109–110; *Bulletin*, 1475. *Local inquiry.*—(*a*) The degree of success of these crops on different local soils should be studied. (*b*) Find the best rotation suitable for these crops. (*c*) Plan a good rotation adapting it to your farm, and see if it throws the sorghum on a suitable field each year.
5. **Growing a cover crop; providing organic matter,** pp. 28, 48, 49, 120–122, 130; *Farm Projects*, 110–112; *Bulletin*, 1250. *Local inquiry.*—(*a*) Find what local rotations will provide sod to turn under for sorghums. (*b*) Ask farmers what cover crops are for winter protection. (*c*) They should be asked to compare the three ways of providing organic matter—barnyard manure, turning under a cover crop, turning under sod in rotation.
6. **Buying and mixing fertilizers,** pp. 27, 44, 45, 123; *Farm Projects*, 112, 113. *Local inquiry.*—(*a*) Find what farmers buy fertilizers for sorghums, millet or cane. (*b*) If mixed fertilizers are purchased, get the different formulas. (*c*) What special ingredients are purchased for each element? N, P, K.
7. **Keeping records,** pp. 3, 18, 19; *Farm Projects*, 32–35, 77, 78; *Bulletins*, 511, 572, 782, 1182. *Local inquiry.*—Draw special forms for record keeping for these crops, and ask growers to help you fill items of costs and returns.
8. **Preparing soil for planting,** pp. 40–42, 50, 51, 122, 127, 130; *Farm Projects*, 113–114; *Bulletin*, 1250. *Local inquiry.*—(*a*) When cover crop or sod is to be turned under, find when the plowing is usually done. (*b*) The opinions of growers should be obtained regarding fall plowing for sorghum. (*c*) Get their opinions regarding the benefits of bare-fallowing. (Page 50.)

9. **Planting and fertilizing sorghums and millet,** pp. 123, 127. *Farm Projects,* 115–116. *Local inquiry.*—(*a*) Describe local planting machines. (*b*) Ask farmers regarding the use of a fertilizer box on the planter. (*c*) Get rates of planting and rates of fertilizing.
10. **Cultivating sorghums,** p. 124; *Farm Projects,* 116–118; *Bulletins,* 414, 660. *Local inquiry.*—(*a*) Make a list of the types of cultivators used. (*b*) Compare these for inter-row tillage. (*c*) Talk with farmers regarding the benefits of cross-harrowing sorghums and cane before and after germination.
11. **Controlling insects and diseases,** p. 124; *Farm Projects,* 75, 77, 118; *Bulletins,* 739, 891, 1025, 1029, 1260, 1307, 1483, 1498, 1566. *Local inquiry.*—(*a*) Get farmers to help you make a list of the most troublesome insects and diseases affecting these crops. (*b*) Their methods of control for each should be learned.
12. **Harvesting sorghums and millet,** pp. 79, 124, 125, 130; *Farm Projects,* 118–121; *Bulletin,* 1577. *Local inquiry.*—(*a*) To what extent is harvesting with livestock practiced for these crops? (*b*) After studying local methods describe the best plan for harvesting for fodder; for seed; for silage; for syrup or for sugar.
13. **Marketing and using sorghums,** pp. 79, 125–126, 130; *Farm Projects,* 121–122; *Bulletins,* 1034, 1158, 1389, 1511. *Local inquiry.*—(*a*) What products of these crops are sold? (*b*) List the home uses of these crops or their products. (*c*) Describe the best methods of selling and of using.

PRACTICES THAT REQUIRE LITTLE EXPENSE

(Ill. Cir. 389)

1. Use high-yielding seeds.
2. Test seeds for germination.
3. Control crop diseases and insects.
4. Store seed and crops carefully.
5. Make careful use of all manure.
6. Protect stand of crops.
7. Prepare a good seed bed.
8. Control weeds by little labor.
9. Grow the higher profit crops.
10. Control livestock diseases.
11. Feed balanced rations.
12. Use home-grown feed.
13. Produce according to markets.
14. Form habits of timeliness.
15. Keep simple farm accounts.

CHAPTER VI

SORGHUM AND MILLET ENTERPRISES

SORGHUMS are of two main types: Those yielding syrups and sugar from the saps of the stems, called sorgo or sweet sorghum; and those used for forage and for grain, such as kafir and its relatives, called non-saccharine or grain sorghum. Sugar cane, millet, and broom-corn, which are close relatives of the sorghums, are also treated in this chapter.

GRAIN SORGHUMS

In the group of grain sorghums or non-saccharine sorghums (Fig. 74) may be included kafir, milo, durra, shallu and kowliang and broom-corn. All of these are used for forage and the seed for feeding livestock. Broom-corn is chiefly used in the manufacture of brooms.

Regions for Grain Sorghums.—This crop is able to withstand dry, hot winds, and is most used in the semi-arid regions where dry-farming methods are most commonly practised. (Fig. 75.) In the belt across the United States, just east of the Rockies and west of the corn belt, kafir and its relatives are abundantly grown. If the annual rain fall averages from fifteen to twenty-five inches these crops are successful under good treatment and dry-farming methods. The great cattle industry of this section is dependent upon the growth of non-saccharine sorghums.

Kafir.—White kafir, black-hull kafir and red kafir are the three main types in the United States. Red, the tallest of these, yields more fodder and grain, but the seed is less relished by livestock because of a slightly bitter taste. The black-hull and white have starchy grains much relished by livestock. The black-hull variety is far the most popular of the three, constituting about 90 per cent of the entire kafir crop.

Durra.—This crop is characterized by large, slightly flattened seeds. The heads in some types are sometimes recurved or hanging down, but feterita has erect heads. Yellow milo is the most popular of the durras, and matures earlier than kafir. The grain is large and easily crushed by mastication. This form is popular in the western parts of Texas and Oklahoma. The stalks are not leafy so the crop is chiefly grown for grain.

Dwarf milo has shorter stems and is still better suited to dry regions. White milo is a variety which is increasing in popularity.

Brown durra is popular in southern California and is also grown in Texas. Feterita is growing in popularity being one of the last of the group introduced into the United States. Its yields are about equal to yellow milo.

Kowliang is grown for grain rather than for forage. It is considered of less value than durra and kafir. It has been used in cross breeding by experiment stations of the semi-arid region.

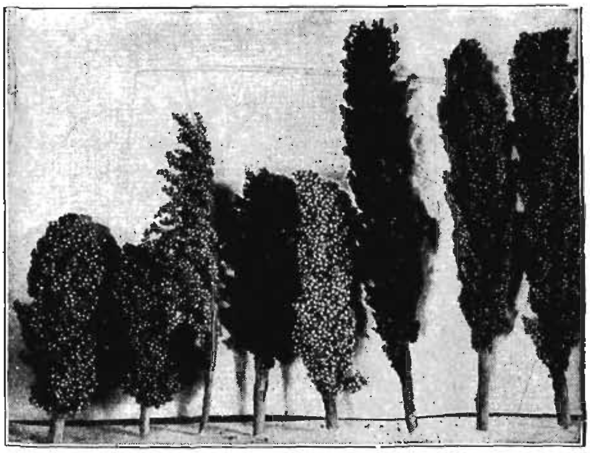


FIG. 74.—Types of grain sorghums. They are well suited to semi-arid regions where they yield better than corn. From left to right: 1 and 2, yellow milo; 3 and 4, white and brown kowliang; 5, feterita; 6 to 8, red, pink and black-hulled kafir. (Woll's Productive Feeding Farm Animals.)

Its early maturity in grain has an advantage in adapting it to the northern part of the dry belt.

Broom-corn.—The chief use of this crop is for broom making. The stems and leaves have most forage value and the seed is seldom used except for poultry. The chief states for the growth of this crop are Illinois, Kansas, Missouri, Nebraska, and Oklahoma. There are two types of broom-corn: (1) Standard broom-corn, with a height of ten to twelve feet and a heavy top twenty to thirty inches long; (2) dwarf broom-corn, with a height of four to six feet and a top twelve to twenty-four inches long. The dwarf form is more grown in the dry regions and the standard form in the moist regions.

Methods of Growing Grain Sorghums.—The soils and their preparation are similar to those used for growing corn except that dry-farming methods are more important. A bare-fallow period

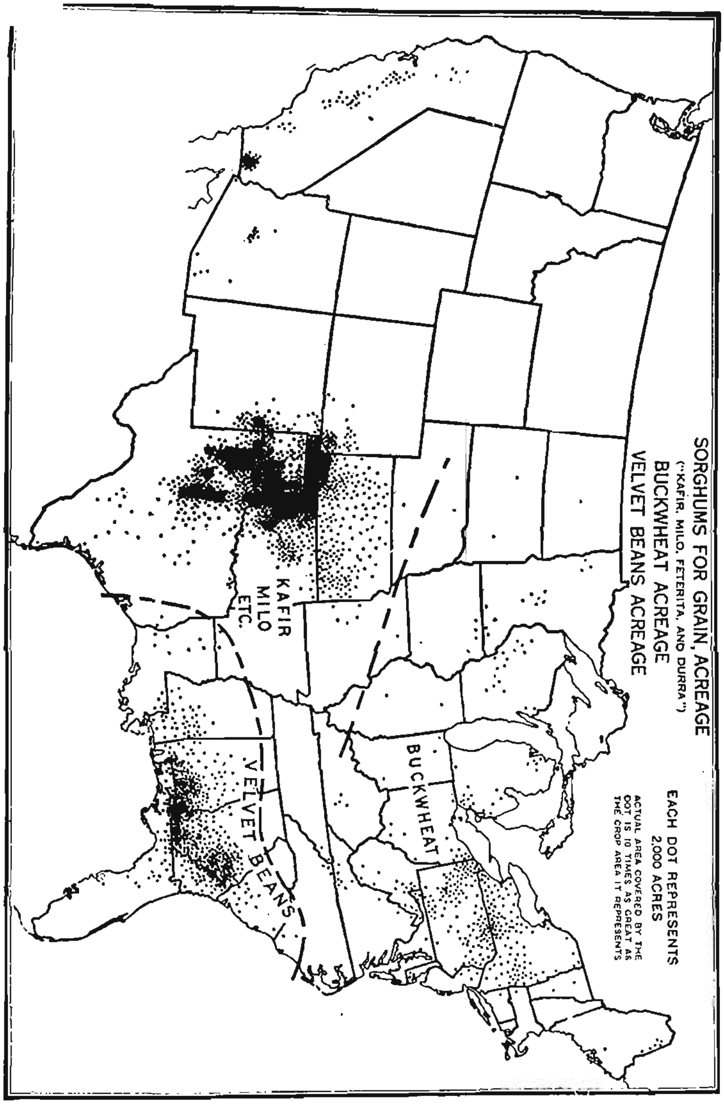


FIG. 75.—Distribution of grain sorghum, buckwheat, and velvet beans, each dot 2,000 acres. (U. S. D. A.)

before planting is necessary to conserve moisture, and in some cases is maintained for a whole year before seeding. More seed is used in the rows than for corn, the plants being only four to six inches apart. As these crops are adapted to hot weather they are usually not planted until all danger of cool nights has passed. Clean cultivation between the rows is very important to maintain a perfect dust mulch.

Harvesting.—The grain sorghums may be harvested with corn binders or with other machine cutters or by hand. The fodder is usually cured in shocks. In regions of little snow fall the practice of pasturing the fields through the winter is often followed. The heads are cut by hand or with headers, and the forage left for livestock.

Dwarf broom-corn is usually harvested by hand by breaking the heads from the stalks in the field. This should be done before the seeds mature as a better quality of brush is thus secured.

Standard broom-corn is handled differently. Before the seed ripens two rows are broken past each other. The process is called "tabling." For this the stalks are bent over two or three feet from the ground. A little later the brush is removed by cutting a few inches below the base of the heads. These are laid on the "tables" and later hauled in for thrashing.

Ordinary thrashers are not used for broom-corn, but revolving cylinders are used to remove the seeds. The brush is cured after thrashing and then bundled for sale to broom factories.

Sorghum Grain.—Poultry feeds, stock feeds, and some human foods are made from the grain sorghums. In feeding value they are about equal to corn, and livestock fatten readily upon them.

Sweet Sorghums

This crop is called sorgo or sweet sorghum because of the juiciness of the pith and the presence of sugar in the juice. The seed is less abundant than on grain sorghums. The early Chinese sorgo has produced Amber sorghum so popular in the southern and central states. Certain native varieties have produced our varieties of Orange, Shumac, and Gooseneck. These and other varieties are grown chiefly east of the Mississippi river, but their use is increasing in the drier belt further west. Because of the length of time required for the maturing of these crops they are less popular in the northern states.

Amber sorghum matures in about one hundred days from seeding. For this reason it is grown further north than other

varieties, but is also popular in the South. It is only five to seven feet in height, with rather loose black heads. Red Amber has red seed heads.

Orange sorghum has short, erect, leafy stems. The seed heads have an orange tinge due to the orange seeds. The heads are long and slightly compact. The crop matures in about one hundred to one hundred and twenty days from germination. This type is popular for syrup production.

Sumac sorghum is also called "redtop" because of its red, compact seed head. The stems are stout, erect, less leafy than orange sorghum and somewhat taller. It matures in about the same length of time as that variety. It is popular in the South, especially in Texas, for making syrup, forage and silage.

Gooseneck sorghum is locally called "Texas ribbon cane" or "seeded ribbon cane." It produces syrup of a peculiarly rich flavor, differing from the other syrup sorghums, but it is not the true ribbon cane or sugar cane of the Louisiana sugar belt. Gooseneck sorghum is larger than the other sweet sorghums, being nine to twelve feet high. Often one-half of the heads are recurved. The stalks are sometimes as large as two inches in diameter at the base.

Soils and Fertilizers.—Any upland or well-drained, fertile soils are suited to the growth of sorghums. Although the sorghums are considered strong feeders, they do not necessarily deplete soil fertility. They do, however, extract the moisture pretty thoroughly and they are good drouth resisters. If the soils be poor the stems or plants are more slender and less syrup is the result. For large yields of syrup use rather fertile soils. As the roots are shallow any application of fertilizer should be made to the surface and lightly worked in with tillage implements.

The soil is prepared very much as for field corn and the seed bed should have a fine surface. Barnyard manure may be spread before plowing. Harrowing just before seeding will aid in keeping the weeds down. If weeds are serious they are apt to smother the fine plants and obscure the rows before they are large enough to be cultivated.

Planting Sorghum.—Sorghum seed should be cleaned of all trash and small seeds before planting. Four to six pounds per acre should make a good stand. Special planting plates, adapted to such small seeds as sorghum, may be used in ordinary corn planters. For syrup production or for fodder purposes have the rows about three and a half feet apart and the plants six to eight inches apart in the row. Seeding is done about two weeks after earliest corn-

planting time, as the seeds should have a warm soil. Very slight covering of the seeds is advised for wet climates. In dry climates and dry soils deeper covering to an inch or more is desired. Sorghum seed is often sown broadcast with cowpeas or soybeans to be harvested for hay. Grain drills or broadcasting methods may be used for this.

Sorghum Cultivation.—The methods used for corn are applicable to sorghum except that the young plants are more easily covered by the first cultivation. Either more time or more care must be used. To remove weeds started before the first cultivation hand hoeing of the rows is more likely to be necessary in a sorghum

FIG. 76.—Cutting sorghum with a corn binder. (Kansas State Agricultural College.)

field than in a corn field. Soil fenders are sometimes placed on sorghum cultivators at first to prevent covering the young plants. If harrowing the field before and after planting and after the young plants are up is thoroughly practised, a tedious task of hand hoeing may be avoided. Unless the winds have bent the plants too much, intertillage may continue until heading time.

Enemies.—*Insects which attack corn crops are somewhat injurious* to sorghum. These have been considered in the corn chapter. Grasshoppers, however, seldom injure sorghum. The damage from chinch bugs, if the attack is made early, is extremely serious.

Sorghum smuts are of two kinds, the kernel smut and the head smut. These are controlled chiefly by rotation and by seed selection.

Harvesting.—Experiments have shown that yields of syrup are greatest if sorghum is harvested when the seeds are in the hard dough stage, that is, rather mature. If harvested earlier, syrup yields are lighter. For silage and fodder, cutting may be in the soft dough stage as the seeds are more easily digested. (Fig.

76.) If hay is desired cutting may take place soon after heading as the leaves will then be more palatable.

If syrup is desired strip the leaves from the plants while standing. *Some growers do this after cutting.* Stripping before pressing increases the percentage of juice and the syrup is clearer.

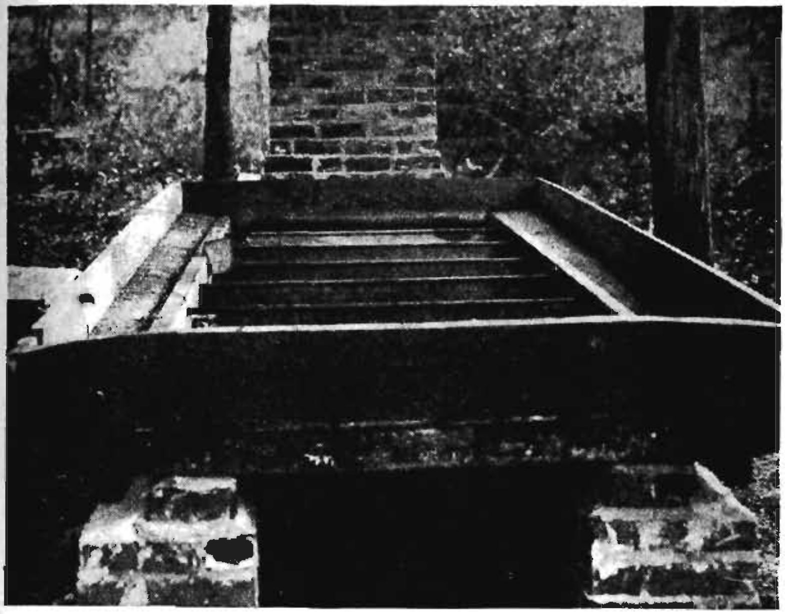


FIG. 77.—Syrup evaporator. Juice placed in at the upper end of the vat flows from one compartment to another until drawn off at the other end. (Florida Station.)

The stalks are harvested by hand methods or by the use of cutting machines.

Sometimes frosts occur before harvest. In such cases harvest should be hastened and the leaves left on the plants for some time. The crop may be put in large shocks to cure. In warm weather, however, when frost has not been encountered the stripped stalks should be pressed very soon to prevent fermentation.

Yields.—Sorghum often yields eight or ten tons of green forage per acre. Because of the good yield it is much used alone or with green corn fodder in making silage.

A ton of cane if well pressed will sometimes produce one-half ton of juice which may produce twenty or twenty-five gallons of syrup, depending on its density. The raw juice varies with seasons

and varieties in the percentage content of sugar. Ten or 12 per cent is often found.

Making syrup consists in pressing out, clarifying, and evaporating the juice. (Fig. 77.)

Heavy cane roller mills are found in each community where syrup is made. The three-roller type is one of the best and may extract more than one-half the juice from the canes. After heavy impurities in the juice are allowed to settle the clear juice is drawn over into other vessels. Some impurities coagulate with heat. These usually rise to the top and are skimmed off. Thoroughness of skimming will improve the quality and appearance of the product. Sometimes one pound of finely powdered yellow clay is added to each five gallons of juice to carry down impurities. The juice is next filtered through charcoal. Skim milk is later added to the filtered juice. This coagulates when heated and removes still more impurities. If the juice then has any strong, bitter or acid taste, it is neutralized by the addition of a small amount of fresh lime or milk of lime, or clear lime water. The lime is added when the juice is hot. Syrup makers pride themselves on their own special methods of making clear, well-flavored products.

The degree of evaporation after the removal of impurities depends upon the product desired. (Fig. 78.) Specially constructed pans for the flow of juice over the heat during evaporation are used where large amounts of syrup are made.

Sugar Cane

This plant is not a true sorghum but resembles the sorghums in manner of growth and general appearance. It is a perennial and in tropical countries lives a number of years. In the Louisiana sugar belt several crops are secured from one planting, but in the northern regions of its growth in the Gulf states replantings are usually made each year.

Sugar Cane Regions.—This crop is best adapted to the moist, warm conditions of the Gulf Coast and is grown in Louisiana, southern Texas, and southern Florida. Important cane sugar regions are Cuba, Java, Hawaii, Porto Rico, and the Philippine Islands. The crop is grown chiefly for syrup production as far north as the southern half or southern third of the other Gulf states, Mississippi, Alabama, and Georgia. Long seasons of growth are necessary for this crop.

Sugar Cane Soils.—The crop requires very rich, black soils,

such as those deposited along shores and streams. Large quantities of water in available form in the soil are necessary. Free, stagnant water on the surface is not desired. The soil must be well drained with the free water table below the roots.

Sour soils must be corrected by drainage, by lime, or other methods. Soils containing a good admixture of sand insure better drainage and less danger from stagnant water.

Manures and commercial fertilizers are usually applied where profitable crops are produced in the United States. If the crops are large, much material is used from the soil annually. This requires the return of fertilizing materials for soil maintenance.

Soil Preparation.—Plow the soil a month or two before planting, if possible. In the sugar belt of the Gulf states this crop commonly follows corn, and soybeans or cowpeas are often mixed with the corn to help supply nitrogen for the sugar crop. These legumes should be plowed under in the late summer or early fall, level plowing being used. The Louisiana Sugar Station recommends the plowing of ridges or beds five feet apart. This is done several weeks after plowing. Water furrows are left between the ridges. These may connect with drainage ditches. This removes the water from the lowlands, but on uplands level methods of preparing for planting are practised.

Planting.—Seed cane is used in planting this crop, as no true seed is produced except in tropical climates. The crop readily grows from the nodes of cane planted in the soil. In some cases the whole cane is planted in the furrow, but in other cases single joints or longer

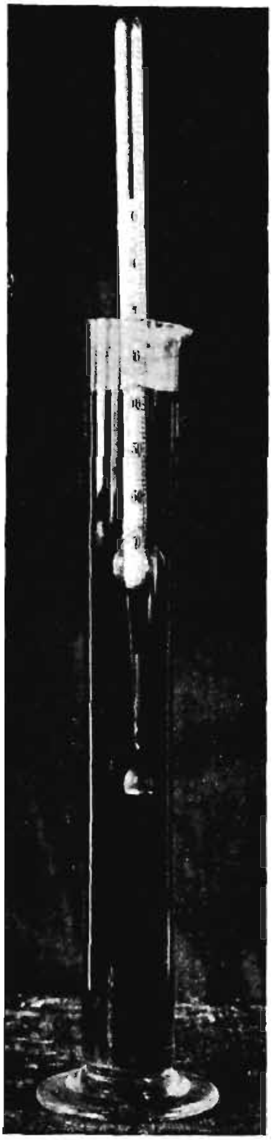


FIG. 78.—Syrup hydrometer. The density of syrup should be standard, 38 degrees Baumé when cold, 33 when hot, and should weigh 11¼ pounds per gallon. (Fla. Sta.)

pieces are dropped in the furrows. (Fig. 79.) The piece method seems to be more common, but experiments show that decay is more likely to follow. Either fall or spring planting may be practised. In the northern counties spring planting is best. This begins as early as the first of March. The canes dropped in open furrows which are four and one-half to five feet apart are covered

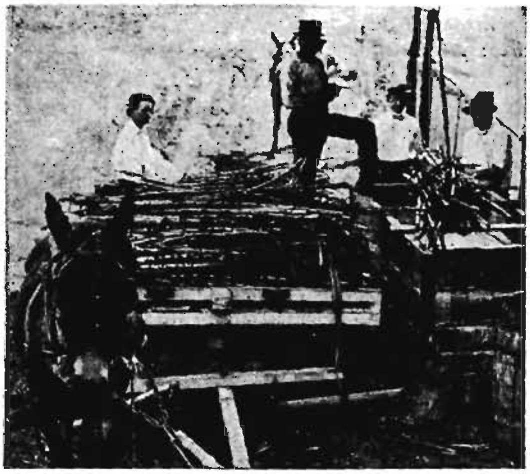


FIG. 79.—Stripped sugar cane to be planted in furrows for the next crop; dipping the "seed cane" in whale-oil soap solution before planting to disinfect it and prevent root disease in the growing crop. (Louisiana Station.)

to a depth of three or four inches. Fall planting is deeper than spring planting.

If soils be dry at planting time the covering should be deeper and a roller used to bring moisture to the planted canes.

Cultivation.—In the syrup-producing sections where this crop is grown the cultivation followed is similar to that used for corn. In the sugar belt proper, much of the cane is planted in the fall to such a depth as to protect it from winter injury. The following spring, cultivation begins by first removing the surplus soil. Harrowing the ridges may be sufficient in some cases, but more commonly a turning plow is used to throw the soil away from the rows. After the crop is well up, cultivation takes place. Later, soil is worked back toward the rows over the fertilizer. Usually moldboard plows are used for this. Various forms of cultivators are used in the middles during the cultivating season until the growth actually stops this work. When a second or third crop is to be

grown from the old stubble cultivation is much simpler. A scraper or "stubble shaver" is sometimes used to remove buds and dried stems, or those containing disease. Then the soil is loosened between the rows with cultivators.

Enemies of Sugar Cane.—The chief enemies of sugar cane are discussed in the Louisiana Station Bulletin 120, to which reference is here made.

Harvesting.—In regions where frosts occur the grower tries to avoid frost by securing as much growth before frost as possible. Where no danger from frosts is feared, maturity is indicated by the lower leaves turning brown. At harvest time the sap should be rich enough to show eight degrees Baumé. Harvesting usually takes place in November or a little earlier.

Stripping, topping, and cutting the stalks with cane knives may take place in one operation. Hand labor is chiefly employed. The stripped canes are taken immediately to mills for pressing out the juice. As cane grows to a height of twelve to fifteen feet the yields are large, often twenty-five to thirty tons per acre. The amount of labor involved in hauling the crop to mill can, therefore, be imagined. Low, heavy wagons are commonly employed. Booms or derricks are sometimes used in loading these. Sometimes railway tracks are laid into cane-growing regions for hauling the crop to mills.

MILLETS

Millets are closely related to sorghum. A number of plants of the grass family belong to this group. They produce crops quickly when grown in the warm part of the summer. They are all shallow rooted and are ravenous feeders.

Types and Varieties.—*The foxtail millets* are most popular, the principal varieties being Common, Hungarian, and German. While Common millet is the most popular of these because of its earliness, it is not so productive as Hungarian, which has larger heads and is very productive of seed and hay. German millet does not tiller so freely as the other two. The heads are nodding and the crop suffers a little more from lodging in high winds.

Broom-corn millet is grown more for seed than for hay, the latter being very coarse and rather unpalatable.

Barnyard millet is a rank weed seldom sown except when unduly advertised by seedsmen. It produces large yields of coarse, fibrous forage and becomes unpalatable. It should seldom, if ever, be used in preference to foxtail millets.

Pearl millet has stiff, erect heads one-half to one foot in length. The seeds are a little smaller than kafir. Its suckers produce second or third growth after cutting. The fodder is much coarser than that of foxtail millets.

Culture.—Millets are all sown in early summer and harvested before frost. They do not endure cool weather or frosts. They will thrive fairly well on rather poor soils, either heavy or light. Rich, sandy loams produce best results.

The soil should be well prepared before seeding as the seeds are small. The foxtail varieties are seeded at the rate of about one and one-half pecks per acre by broadcasting methods and harrowing to slightly cover the seeds. If twice as much seed is used the hay will be much finer. When hay is the main purpose the seed should not be allowed to ripen. Cutting may begin soon after

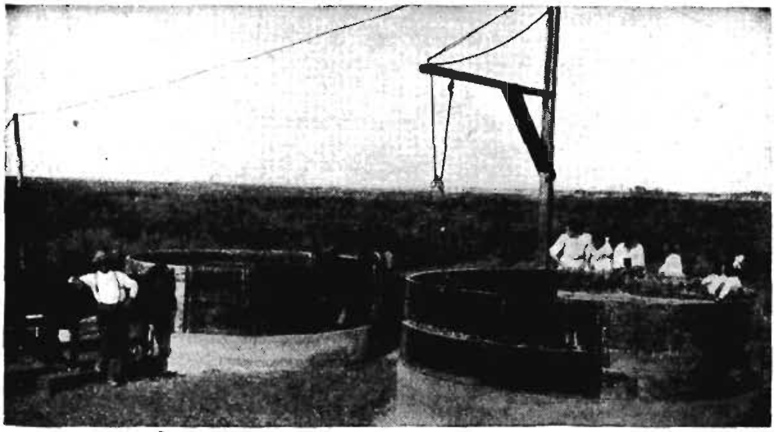


FIG. 80.—Curbs of two pit silos, Sulphur Spring Valley, Ariz. No extra power is required to elevate the silage at cutting time. Cured silage is removed in baskets suspended from a crane. (Arizona Station.)

the formation of heads. When allowed to mature the seed should yield, when thrashed, about fifteen to twenty-five bushels per acre. Seeds from millet are used in poultry feed mixtures.

Millet and cowpeas are often sown together for hay. Use one bushel of cowpea seed with one peck of millet per acre. The crop should be cut before the millet seeds are ripe and at that stage is not difficult to cure.

Surveys, Trips, Exercises, Projects, and Problems

1. **Surveys.**—Make a local survey to ascertain what varieties of these crops are used; what methods of planting and cultivation are followed; what yields are secured; cost of production; what uses are made of the products.

2. **Problems.**—Students should make problems from the results of the local surveys. Get average yields from the reports. Compare costs of production with yields and from these calculate profits.

3. **Wall Charts.**—Make charts on sign cloth about three by four feet

Study the wording of each chart carefully before lettering. Some subjects for charts are suggested: Steps in preparing the soil; field selection of seed; reasons for bare-fallow; items in cost of production.

4. **Pictures for Placards.**—Get free bulletins from the stations of states growing these crops. Also write to seed companies for illustrated catalogues. Classify pictures cut from these according to types. Label each placard by using neat lettering.

5. **Debates.**—Good subjects for debates regarding these crops are as follows: "*Resolved, that kafir corn is better than ordinary field corn for* growing here," "Resolved, that durra or milo is better than kafir," "Resolved, that sweet sorghum should be grown rather than grain sorghum," "Resolved, that plant breeders should strive to extend the northern limit of growth of grain sorghums."

6. **Field Trips.**—Plan field trips to study depth of planting; kinds of seed used; preparation of soil; methods of cultivation; methods of harvesting; thrashing of grain; making of silage (Fig. 80); comparison of varieties.

7. **Production projects** should be planned by students living in states where these varieties are grown. Make a complete list including every step in the production of the crop. Opposite these indicate the studies involved for each and the references for each.

8. **Trials with Projects.**—Plans should be made by which certain methods can be readily compared during the growth of the crop. Various tests may be made. Dry-farming methods should be compared with others. Certain kinds of fertilizers, if at all needed, may be compared.

Feeding Values in and Fertility Removed by Sorghums and Millets

Name of feed.	Dry matter in 100 lbs.	Digestible parts in 100 lbs.		Fertility in 1000 lbs.		
		Protein	Carbohydrates (+ fat × 2.25)	Nitrogen (N)	Phosphoric acid (P_2O_5)	Potash (K_2O)
Broom-corn fodder	90.6	0.6	47.	10.2	...	....
Feterita grain	88.9	10.	71.	20.0	5.7	3.1
Feterita head chops	88.8	7.	64.9	17.8	...	....
Kafir grain	88.2	9.	71.	17.8	5.7	3.1
Kafir head chops	87.5	6.1	61.	15.5	...	....
Kafir dry fodder	91.	4.1	48.8	14.2	...	....
Molasses, black strap	74.	1.	58.5	5.1	2.4	31.6
Millet seed (all)	90.	8.2	69.2	18.5	5.9	4.5
Millet hay (all)	88.3	4.8	50.4	12.8	4.2	20.6
Milo grain	89.3	8.7	70.7	17.1	7.8	4.3
Milo fodder	88.9	1.9	42.6	19.2	...	....
Sorghum grain (sweet)	87.3	7.5	72.	14.7	8.2	3.3
Sorghum fodder (dry)	90.3	2.8	49.3	11.8	...	....
Sorghum bagasse (dry)	88.7	0.5	53.7	5.4	...	....

Questions and Investigations

1. What are the advantages of grain sorghum over corn?
2. Compare durra and kafir.
3. Compare the different types of broom-corn.
4. Describe methods of growing grain sorghums.
5. Describe harvesting grain sorghums.
6. Compare amber sorghums with other sorghums.

7. Describe methods of planting sorghum used locally or elsewhere; the culture.
8. What uses are made of sweet sorghum crops?
9. Describe harvesting for each.
10. Describe the making of syrup.
11. What regions are suited to sugar-cane growing? What soils?
12. Describe the planting of sugar cane; the cultivation.
13. Describe the harvesting of sugar cane.
14. What types of millet are grown locally? Enumerate other types.
15. Describe the culture and give uses of millet.

Farm Mechanics.—Make or repair hand drill; head stripper; head cutting rack and knife; leaf stripper; sorghum vat and fire place; low frame for hauling. Repair thresher, harvester, cane mill.

Calculations.—1. A farmer made a low frame for hauling green fodder to cattle, to cane mill and to silo. This cost $16 for materials only. He saved ⅓ the hauling labor on an 18-acre crop yielding 10 tons of green fodder per acre. He formerly hauled 6 tons at a labor cost of $2. Find his former and present cost of hauling such a crop.

2. What was this farmer's labor income for making the low hauling frame, if spread over a 5-year period of such hauling?

3. Find the yield of syrup per acre from three tons of stripped cane yielding 40% juice which makes ⅓ as much syrup. Find its value at 90¢ per gallon. (Fig. 78.) Allow 12 lb. per gallon.

4. In one year 60 acres of grain sorghum yielded 2,100 bu. of threshed grain. Calculate the yield per acre, and the total value at 67¢ per bu.

5. Dent corn has 7.8 per cent. and kafir grain contains 9 per cent of digestible protein. How much corn would be needed to furnish as much protein as does a ton of kafir?

6. The carbohydrates-plus-fats in corn are 76.5 per cent; in kafir 71 per cent. How much in a ton of each?

7. From problems 5 and 6 find the total feeding values of corn and kafir. If corn is rated at 100 what is the rating of kafir?

GRASSES FOR HAY AND PASTURE

Analysis into Jobs.—The following teaching units include the main ›bs in growing and making use of meadows and pastures involving the ifferent grasses. References are to pages in *New Agriculture*, Davis' *Farm 'rojects and Problems*, Montgomery's *Productive Farm Crops* and available '. S. *Farmers' Bulletins*. See *Field-Crop Enterprises*.

1. **Deciding whether or not to grow a grass crop,** p. 132; *Farm Projects*, 123; *Farm Crops*, 317–328; *Bulletins*, 945, Bermuda; 990, Timothy. *Local inquiry.*—(*a*) Study the yields of grasses and the success of pasture grasses. (*b*) Get the opinions of farmers regarding the advisability of growing grasses for hay and pasture. (*c*) Study the cost of establishing pastures and hay fields. (*d*) Compare the net returns from grass crops with net returns from other crops.
2. **Choosing crop or the mixture,** pp. 132–144; *Farm Projects*, 123–128; *Farm Crops*, 137, 343–366; *Bulletins*, 945, Bermuda; 990, Timothy; 1126, Sudan; 1254, 1433, 1555, 1602. *Local inquiry.*—(*a*) Which grasses are most successful for hay and which for pasture, locally? (*b*) Inquire regarding the endurance of the different grasses grown locally. (*c*) Which of the grasses seem best suited to local rotation systems? (*d*) What grasses are most popular and why?
3. **Deciding on soil, field and acreage,** pp. 34, 39, 86, 132, 133, 159; *Farm Projects*, 129; *Farm Crops*, 313, 317–322; *Bulletin* 990. *Local inquiry.*—(*a*) Ask farmers their opinions regarding which local soils are best suited to grass growing. (*b*) Ask them what improvements are needed to make soils suitable for grasses. (*c*) Find areas used for grass on local farms. (*d*) Compare soils and other differences in fields in their suitability to permanent grasses; to short rotations.
4. **Securing good seed; cleaning; testing,** pp. 32, 33, 36, 66, 472–474; *Farm Projects*, 129, 130; *Farm Crops*, 321–336; *Bulletin* 990. *Local inquiry.*—(*a*) Find how grass seed is procured by local farmers. (*b*) Compare the methods, giving reasons for and against each. (*c*) Obtain seed sample from local dealers and farmers and examine for impurities. (*d*) Report to farmers what weed seeds are found in these samples.
5. **Buying and mixing fertilizers,** pp. 27, 44, 45, 69, 70, 145, 166; *Farm Projects*, 130; *Farm Crops*, 338, 340. *Local inquiry.*—(*a*) Ask farmers how they know what fertilizer ingredients are needed. (*b*) Ask them regarding the advisability of buying fertilizers coöperatively.
6. **Preparing the field for sowing,** pp. 40–42, 50, 70; *Bulletins*, 660, 990. *Local inquiry.*—(*a*) Find the time for sowing grass seed with nurse crops; alone. (*b*) Ask farmers regarding different nurse crops for grass, and get their opinions. (*c*) Get them to compare firm and loose seed beds for grass.
7. **Liming the field,** pp. 43, 44, 166; *Farm Crops*, 313, 314, 341, 342, 346. *Bulletin*, 921. *Local inquiry.*—(*a*) What farmers lime in rotations including grass? (*b*) How many lime permanent grass fields? (*c*) Get the opinions of farmers regarding the advisability of liming for grass alone; in clover mixtures; with nurse crops. (*d*) Locate the nearest lime kiln and lime crusher for your region. (*e*) What rates of liming are considered light? Heavy?

8. **Sowing and fertilizing**, pp. 70–72, 133, 134, 145; *Farm Projects*, 131; *Farm Crops*, 326–328, 340, 341, 345; *Bulletin*, 990. *Local inquiry.*—(*a*) Find rates of sowing alone; with mixtures; with nurse crops. (*b*) Find local methods of sowing. (*c*) Find best times for sowing grass in your region. (*d*) What implements are used just before and after sowing? (*e*) What fertilizing is done at or near this time? (*f*) Get farmers to compare smooth rollers with rough rollers when seeding grass.
9. **Caring for crop and cultivating**, pp. 133, 142, 143; *Farm Crops*, 342, 346; *Bulletin*, 990. *Local inquiry.*—(*a*) Ask local farmers how they maintain pastures. (*b*) Then ask them particularly about clipping, harrowing, reseeding and top-dressing. (*c*) Ask them which of these cases would apply to hay fields. (*d*) Find the reasons for some who do not practice these.
10. **Controlling enemies**, pp. 76, 77, 152; *Farm Crops*, 342, 347; *Bulletins*, 660, 990, 1247, 1307. *Local inquiry.*—(*a*) Ask farmers to compare weeds with insects and diseases regarding injury to grass lands. (*b*) List the kinds of weeds and classify them into annuals and perennials. (*c*) List the cases of disease and insects found in your region.
11. **Harvesting and curing hay**, pp. 143, 154–156; *Farm Projects*, 132–134; *Farm Crops*, 346, 347; *Bulletins*, 990, 1525, Haying, 1615. *Local inquiry.*—(*a*) Find the best practices in curing hay. (*b*) Find the stages in which the different grasses are cut for hay. (*c*) Ask many growers and determine the average yields of hay. (*d*) Compare rapid curing with slow curing methods in your region.
12. **Harvesting seed and thrashing**, pp. 142, 153, 162; *Farm Projects*, 134; *Farm Crops*, 330, 334, 355; *Bulletins*, 990, 1525. *Local inquiry.*—(*a*) What grasses are grown particularly for seed in your region? (*b*) Describe local methods of harvesting and of thrashing the seed crop. (*c*) How is the seed cleaned after thrashing?
13. **Using and maintaining pastures**, pp. 132, 332, 358; *Farm Crops*, 318–320, 349, 353, 354; *Bulletins*, 660, 990, 1475. *Local inquiry.*—(*a*) Find what care growers exercise in pasturing to prevent destruction of grasses. (*b*) Make a list of farmers who have permanent pastures only; those who have temporary pastures only; those who have both. (*c*) Compare using and misusing of pastures.
14. **Feeding hay crops**, pp. 166, 357, 468, 469; *Bulletin* 990. *Local inquiry.*—(*a*) To what classes of livestock are the different hay crops of your region fed? (*b*) Find how many different plans of handling and feeding the crop are in use. (*c*) Choose the best of these and give reasons.
15. **Baling hay and marketing hay and seed**, 144, 156; *Farm Projects*, 135, 163; *Bulletins*, 990, 1525, 1615. *Local inquiry.*—(*a*) Compare local hay balers in size, power, mobility and speed. (*b*) Find the different plans of marketing hay and grass seed. (*c*) Compare these and give reasons for and against different plans.
16. **Keeping records**, pp. 18, 19; *Farm Projects*, 32, 35, 78, 79; *Bulletins*, 511, 572, 782, 1182. *Local inquiry*—(*a*) Inquire from farmers the cost of items in starting, maintaining and harvesting grass fields. (*b*) Get one of the best growers to help you summarize the net returns from hay or from pasture.

CHAPTER VII

GROWING GRASSES FOR HAY AND PASTURE

TRUE grasses and legumes are the two main families of plants used for hay and pasture. In the preceding chapter several annual members of the grass family are discussed. Many of those are used for both grain and forage.

For pasture and hay perennial grasses are much more important than annual grasses. A true perennial grass is one which lives from year to year whether seeds be formed or not. It may, if allowed to do so, produce seed each year.

Pastures are of two main types, temporary and permanent. A pasture may be temporary (1) because it has temporary or annual crops in it; (2) because the farmer wishes to use the crop only temporarily for pasturing livestock and then use it for some other purpose; thus winter grains are pastured for a few weeks and then saved for grain. If alfalfa or clover or timothy be pastured for a few weeks in early spring and then reserved for a hay crop, it is a temporary pasture, although the crop is rather permanent.

Permanent pastures are those which are fenced and seeded with long-lived perennial crops which will endure pasturing well. The crops in permanent pastures are made to endure the treatment better in several ways: (1) By reseeding thin or bare spots; (2) by harrowing when ground tends to crust or bake; (3) by mowing the weeds and preventing them from seeding; (4) by top dressing with lime and commercial fertilizers; (5) by not pasturing too closely nor too early in the spring; (6) by removal of livestock when the soil is muddy.

Grasses for Permanent Pastures.—As permanent pastures are usually located on some part of the farm not best suited to the production of cultivated crops, it is necessary to select pasture grasses which are adapted naturally to the particular kinds of soil and other conditions. Such places are low, wet lands, wood lots, stumpy fields, rocky fields, poor uplands, steep hillsides, and combinations of any of these. This wide range of conditions calls for a wide range of adaptability of pasture plants to fill them.

Some qualities of a good pasture grass are given: (1) Living for many years; (2) forming an even sod, not in bunches; (3) enduring drouth well; (4) shallow rooted to endure poor drainage; (5) endure tramping of livestock; (6) beginning growth early in

spring and continuing growth through much of the cool weather of spring and fall; (7) palatability; (8) making new growth quickly after cropping.

Among the best pasture grasses to fulfil most of these requirements are Kentucky blue-grass for the states east of the Missouri River and north of the Gulf states; Bermuda grass for the southern states east of the semi-arid regions. In the semi-arid regions smooth brome grass is one of the best for permanent pastures. It is supplemented by buffalo grass and other native grasses.

Pasture Mixtures.—The benefits of growing several different kinds of plants together for pasture or for hay should be noted: (1) Different depths of feeding of roots, avoiding competition, and using the soil to better advantage. (2) Some may endure the shade of others and thus cover the surface better. (3) Their plant food requirements differ. (4) Some thrive better in heavy soils while others thrive better in sandy or otherwise different spots, as alkali, or lime, or sour soil. (5) Some grow better in cool moist weather and others endure the hot, dry seasons. (6) Some endure close cropping, while others remain succulent when allowed to grow tall.

In comparatively dry regions of the western states smooth brome grass is often mixed with blue-grass, white clover, red-top, and timothy. In the Gulf states and other southern states, the small cereal grains are often sown with burr-clover, to produce winter pasture. Burr-clover and Bermuda may be grown together. Bermuda is good for summer and burr-clover for winter. Hairy vetch may be mixed with the small grains for winter pastures. Lespedeza is of much help to the summer pasture when mixed with Bermuda.

In the blue-grass section timothy is often mixed with it for uplands. Red-top is also used if the pasture is low and wet. Creeping white clover is excellent in pastures if not allowed to blossom and seed too much.

Grasses for Hay.—Among the qualifications for a good hay grass the following may be mentioned: (1) Have good yields; (2) regrowing after cutting; (3) remain palatable through a fair proportion of its growth; (4) be leafy; (5) produce plenty of seed; (6) live several years; (7) be easily cured. Wild grasses often fulfil several of these conditions. (Fig. 81.)

Several of the arguments given for mixtures in pastures hold for hay mixtures. In the cooler, humid regions of the United States, timothy is the leading grass for hay. Smooth brome grass

and a number of native grasses are used in the semi-arid sections. It is difficult in southern states to find distinctive grasses so well adapted to the section for hay purposes. Johnson grass most nearly fulfils the requirements, but is a persistent weed and not suited to a rotation system. In the Gulf states Bermuda grass is much used for hay and Rhodes grass is suited to the best soils where frosts seldom occur. A little further north orchard grass, red-top, Italian rye grass, tall meadow oat grass, and fescue find favorable

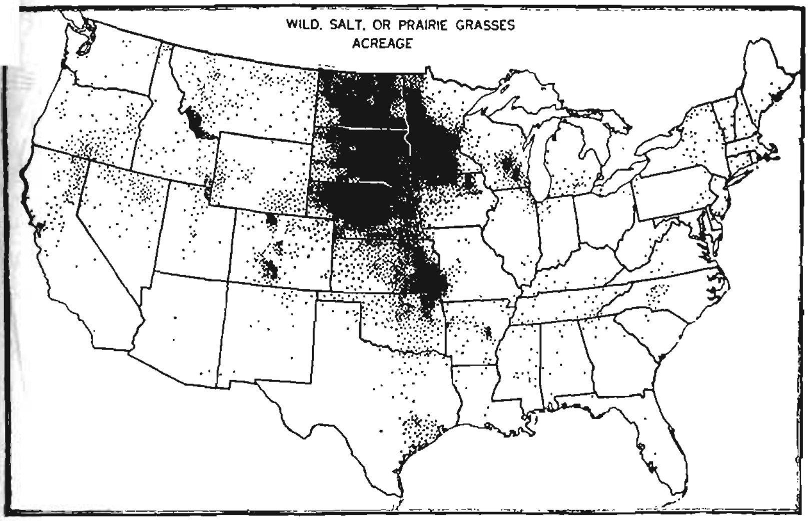


FIG. 81—Distribution of wild grasses used for hay. Each dot 2,000 acres. (U. S. D. A.)

conditions in different sections. The mixture of clovers and other legumes with these grasses for hay greatly improves the quality and feeding value of the crop.

Timothy.—This grass is grown on probably a fifth of the area of the United States devoted to hay and forage. On another fourth of this area timothy and clover mixed constitute the crop. It fulfils practically all of the seven points of a good hay plant. (Fig. 82.) It is adapted to a wide range of soils, but prefers moist climates where the summers are not too long. It is well adapted to four-year and five-year rotations.

Seeding is done in one of four ways: (1) The seed may be sown in fall when fall grains are sown or drilled; (2) in spring grain regions the seed is sown with small grains in the spring; (3) on fields of fall grain the grass seed may be sown the following spring and the surface rolled or harrowed to help cover the seed

slightly; (4) in late summer or early fall the crop is sown alone on well-prepared soil; (5) in some sections such as New England, timothy seed is sown in corn fields after the last cultivation in July or August, a level surface being left for the purpose.

The amount of seed per acre varies from eight to twelve pounds, but more is sometimes used. Good seedings are often secured where manure from timothy hay is used as a top dressing on grain fields during the winter, no extra seed being used. In the above-mentioned plans of seeding, red clover is often mixed with timothy seed at the rate of five to eight pounds per acre. Standard seed should be used and no weeds should be sown with it. Poor stands are often due to use of foul seed. Broadcast methods of seeding give satisfactory results as little covering of the seeds is necessary. When grass seed attachments are used on drills the seed should fall behind rather than in front of the main drill.

FIG. 82.—Timothy is the most popular grass for hay, best suited to humid parts of the northern states. (U. S. D. A.)

Hay from Timothy.—The hay is more palatable when the crop is cut in full bloom or soon after. If the crop stands until the seed is in the dough stage, or fully ripe, the yield of hay and the total amount of seed per acre are greater. Between these two extremes the farmer is required to strike a happy medium, depending upon favorable weather conditions for curing the crop. It is more easily cured when rather mature and less damage will result if weather is favorable. Farmers are required to handle large fields by beginning the cutting in the early stage so as to finish before any of the field is too ripe. July is the chief hay-making month for the first cutting. A second cutting, later in the summer, is often secured. Rowen is a name given to the second cutting of hay from grass.

Curing.—As timothy is one of the easiest grasses to cure for hay its management in hay making may be taken as a type for all. One plan commonly followed is to mow the hay as soon as the morning dew has dried off. Let it lie in the swath until next day,

then rake during the heat of the day and before night throw into tall, narrow shocks, where it is allowed to remain until the next day and then is hauled into the barn, or stack.

Another plan is to mow and rake as before. Throw it into piles and haul it in the day following the evening it was mowed. This plan suits when the crop is rather mature, and the weather is hot, dry and somewhat windy.

Fig. 83—Kentucky blue-grass forms a dense even turf and is popular for lawns and permanent pastures. (U. S. D. A.)

A third plan is to leave the hay in tall, narrow shocks two days instead of one as mentioned before. This plan is sometimes necessary when the crop is cut early and when weather conditions are rather unfavorable for hay making.

When seed is to be thrashed the crop is cut when the seed is rather mature but will not shatter badly. The straw, after thrashing the seed, is used as roughage for idle work stock.

Kentucky Blue-grass.—This crop is by far the leading pasture grass of America. It, more nearly than any other, fulfils the requirements of the ideal pasture plant. (Fig. 83.) In many parts of its habitat it improves its stand by years. It will spread to new fields frequently without seeding. The legal weight of seed is fourteen pounds per bushel, but when recleaned and the chaff blown out, it may weigh nearly twice as much. June is the month for ripening the seed. In northern states the name June grass is often given to this grass.

When seeding is to be done a fine seed bed should be prepared. Moist, cool weather is best for germination and continued growth.

In the northeastern states lawns and pastures are seeded at various times in the year, but very early spring seems to be most common.

August or September seedings are usually very successful. In the Ohio Valley fall, winter, and early spring seedings all give good results. As the seed is low in percentage of germination, the amount of seed used per acre varies from fifteen to thirty pounds. Sometimes more than this highest rate is used for lawns.

Sowing with a nurse crop, such as small grains, or with other grasses and legumes, is commonly practised. The seed is slow in germination and the small plants require considerable time to become well established and occupy the ground. The other crops may be out of the way in plenty of time. White clover is very commonly mixed with blue-grass for the finest lawns. When high enough the lawns should be kept clipped closely, causing the runners and underground stems to spread and form a tough sod. All weeds and annual grasses should be kept out well. A top dressing of half-rotted manure applied in the fall or during the winter will improve lawns greatly. Lime and commercial fertilizers also help.

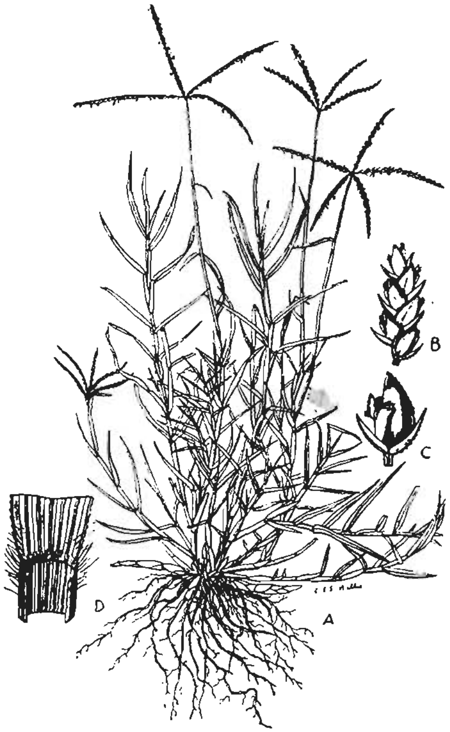


Fig. 84.—Bermuda grass. A, entire plant showing habit; B, part of a flowering branch, showing arrangement of spikelets; C, spikelet much enlarged; D, junction of blade and sheath. (U. S. D. A.)

Canada blue-grass is a very poor grass, but its name and appearance cause it to be confused with Kentucky blue-grass. Its head is less opened and the stems less erect. The grass becomes very tough and wiry and is really objectionable in pastures. The name "wire grass" is sometimes given it by farmers.

Bermuda grass (Fig. 84) is more commonly grown for pas-

tures than for hay in the South. It becomes too tough for profitable hay production in the Gulf states. It spreads rapidly by means of rooting stems and underground root-stocks and makes a dense mat well suited for holding soil on hillsides and terraces. During drouth and in winter, the tops turn brown and are apparently dead, but when weather improves new growth shoots up from beneath the surface and a greensward is soon formed. When closely pastured the growth is very succulent and palatable. Farmers consider it a pest where rotation of crops is desired, as when well established the grass is difficult to eradicate.

FIG. 85.—Orchard grass grows in dense clumps, and endures shade well. (U. S. D. A.)

Bermuda grass is readily started by preparing the soil as if for seeding, then sowing fresh-mown cuttings and rolling them in with a cultipacker or other rough roller. This usually plants them sufficiently for growth if the weather is favorable. As each plant spreads rapidly a thin sprinkling of cuttings is sufficient.

Seeding is also practised, but the seed is scarce and expensive.

Planting pieces of sod broken from shallow furrow slices is another way of starting the crop. These are dropped about two feet apart in very shallow furrows and rolled in.

Orchard grass (Fig. 85) is well adapted to the region where timothy is chiefly grown, but its area extends farther south and farther west. As much of its growth is made early in the spring when soil moisture and weather are favorable, its blossoming and seeding are fully a month earlier than timothy. A tall, heavy growth, well suited to hay, makes this grass popular in many sections. It endures shade well, hence the name orchard grass. It grows in tufts or clumps instead of an even turf, which makes it less suited for pasturing purposes. It remains in condition for cutting for hay only a short period. This is just after the blossoming

stage. If allowed to stand much longer the stems become woody and fibrous and less palatable for livestock.

Red-top grass (Fig. 86) is adapted to the same climatic conditions as timothy, but will endure a wider range of soils. While it is used on uplands it will endure low, wet fields. It will produce fairly well on soils rather too poor for timothy. While its shallow roots cause it to suffer in dry weather, it readily recovers when rain comes. It produces an even, tough turf such as we desire in pastures. Golf-links are sometimes seeded with mixtures of this and blue-grass, particularly if the area is low and sour.

It may be seeded in very early spring with grains or sown alone in August or as soon as the soil is moist after that. It produces fair yields of hay, beginning the next year and lasting many years. The seed is light and chaffy, resembling blue-grass, and is seeded at about the same rates.

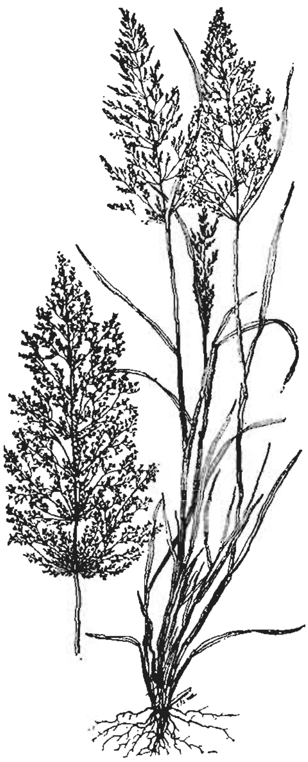


Fig. 86.—Redtop grass, a perennial forming a coarse, loose turf. (U. S. D. A.)

Brome grass is becoming more popular as its qualities are better known. Its introduction from Europe is comparatively recent. It is well suited to semi-arid regions, to the Great Plains and the northern Pacific slopes. While it is well suited to timothy regions, it may never compete with that crop. It has leafy stems, well suited for hay if cut in the proper stage, soon after blossoming. The seed is very abundant and grows well. Four or five hundred pounds of seed per acre are sometimes thrashed when the crop has been cut with a binder for this purpose. Fifteen to twenty pounds are used per acre when sown alone in late summer. One-half this amount is enough in mixtures or with nurse crops. The seed resembles quack grass seed, with which it is apt to be mixed. There is danger of starting quack grass, which is a bad weed. Seeding in grain fields in early spring is commonly

practised. It is sometimes sown in well-prepared seed beds in August or as soon as moisture conditions are favorable.

The roots are provided with running root stalks, which cause the plant to form a tough, even sod well suited to pasturing. The crop, under favorable conditions, will stand for a number of years. Disking and harrowing will sometimes improve the stand if the roots become sod-bound. After becoming sod-bound, yields of hay are greatly reduced. This has led to the practice of cutting the crop for hay the first two or three years, and using it for pasture after that. In palatability it is comparable with Kentucky blue-grass.

FIG. 87.—Perennial or English rye-grass lives only a few years. It is used in meadow, lawn, and pasture mixtures because of its rapid growth the first year. (U. S. D. A.)

Meadow Fescue.—Several types of fescue are suited for pastures. They form an even turf and last for several years. The tall form is best adapted for hay. Fescues are seldom sown alone, but are valuable in grass mixtures. Their climatic requirements are about the same as for timothy, but they are also used farther west where the climate is drier. As they run wild readily they are often found in mixtures of wild prairie hay.

Rye grasses are popular in Europe and are gradually becoming more used in this country, particularly in mixtures with other grasses. When sowing blue-grass, for example, some Italian rye grass, if mixed with it, will produce a greensward much quicker, and as the rye grass is short-lived the blue-grass will later take its place. The leaves resemble those of blue-grass but are a little broader. English rye grass, also called perennial rye grass, is sown with lawn grasses. (Fig. 87.)

Carpet grass is used in the South for light, sandy soils where Bermuda grass does not thrive so well. It is found chiefly in the south half of the Gulf states, where it is used abundantly in pastures. When frost begins the grass ceases growth, but still supplies good pasturage, if not too short. It produces a smooth, even sod, as the name indicates, and lasts several years. It is started

in a field by scattering or planting small pieces of sod and then rolling the soft field. The crop naturally forms seed, if allowed to do so, and the mowings from such a field are spread on other fields. This may be done at any time when the soil is moist as in the fall or early spring.

Johnson grass is closely related to the sorghum family of

FIG. 88.—Left, root of Sudan grass. Right, Johnson grass, underground stems and roots, showing joints where shoots may grow, making it a bad weed. (U. S. D. A.)

grasses. It is now thoroughly established in the southern states and is considered a serious pest in most sections. Unless cut frequently during each year the stems become coarse, fibrous and unpalatable. An abundance of seed is produced by the plants and the large rhizomes beneath the surface of the soil spread the plant and make it difficult to eradicate. The laws of most states forbid the seeding of this crop, but in the southeastern states such laws are seldom rigidly enforced. Most farmers of the Johnson grass region know the crop well and realize that it cannot be entirely stamped out. They make the best of it by cutting it frequently for hay.

Where fields have been taken by scattered patches of this grass other grasses, such as Sudan, or such crops as alfalfa, are sown in the field and the Johnson grass is cut with them, producing mixed hay. When cut thus often Johnson grass is quite palatable and useful for livestock.

FIG. 89.—Sudan grass, a tall annual plant, similar to Johnson grass, but without a running rootstalk. (U. S. D. A.)

Cutting often prevents seeding and hay is then not dangerous to handle on the farm or in the markets. In its northern limits shallow fall plowing will help to stamp out the grass by allowing the frost to kill the underground stems. Small patches are sometimes pastured with swine. As the rootstocks are succulent, swine will root them up for feed. (Fig. 88.)

Sudan grass (Fig. 89) is of rather recent introduction and is not widely grown in the United States. It is well suited to dry climates, but thrives in humid regions also. In growth and seed it greatly resembles Johnson grass, and unless cut frequently is no more desirable as hay. The crop is relished by livestock as pasturage if grazed closely or trimmed. It is strictly an annual crop in its root system and there is no danger of its becoming a pest on the farm. Sudan seed, however, sometimes contains Johnson grass seed and farmers can hardly afford to risk planting it, unless the source of the seed is positively known. About one and a half pecks per acre should give a good stand as the plants tiller freely. Seeding is done after all danger of spring frost is over and the crop should be cut two or three times and before much heading takes place, if palatable hay is to be secured.

Methods of harvesting grass seed differ in different regions and with the various grasses. Timothy is mown when ripe and the seed is thrashed with ordinary thrashers having grass-seed cylinders and concaves. The same is true of brome grass, orchard grass and others. Special seed-gathering machines have been rather

generally introduced in some sections to be used for small-seeded, chaffy grasses such as red-top and blue-grass. In some cases, as with brome grass, the crop is cut with a binder instead of a mower. It can then be cured in shocks as is small grain before thrashing.

Yields and Weights of Grass Seeds and Amount Used in Seeding

Name of grass	Yields pounds per acre	Pounds per bushel	Pounds sown acre	Millions of seed per pound
Bermuda	....	36	20	2
Blue-grass	100–200	14	20–40	2–4
Brome, smooth	500	14	20	....
Orchard grass	150-250	14	15–35	½
Red-top	....	14	12–18	4–6
Timothy	400–500	42–48	8–15	½–2

Hay-making Machinery.—Common mowing machines used in cutting grasses for hay are familiar machines on most farms. They are usually drawn by two horses. The sickle-bars vary in length, but are usually between four and a half and seven feet in length. Attachments have recently been made by which sickle-bars are operated by the side of small tractors. Safety devices provide against breakage when such machines strike stumps or other obstacles.

Rakes are of several types. The side delivery rakes are less common than other forms, but are becoming popular for use where the hay is not too long. Hay loaders save man labor and are used where large quantities of hay are to be handled quickly. On small farms this form of loader is seldom found.

Hay forks are of several forms and are used for unloading hay wagons to stacks and into mows. Some of these are capable of lifting a load of hay in four to eight trips. They save much time and make it possible to use horse power instead of man power in lifting the hay and dragging it back into mows.

Hay balers make bales of three main sizes. (Fig. 90.) In many of them bales may be varied in length to suit the operator. Balers are very useful in compressing hay to be stored in smaller spaces and to be shipped to market. Balers are usually operated by horse power, but gasoline-driven balers are becoming more common. Power balers are often provided with self-feeding attachments. These help guard against accidents.

Feeding and Fertilizer Values of Hays and Grasses.—A very good idea of the differences in feeding values of the various grasses, whether as pasture or as hay, may be seen by the figures given in the accompanying table. At the right in the table are

shown the amounts of the three leading fertilizer ingredients, from which the amount of fertilizer removed by a crop of hay can be learned.

Market Classes of Hay.—On the leading hay markets the various classes of hay are based upon the standard classifications of timothy hay which are Choice, No. 1, No. 2, No. 3, No Grade.

Choice timothy must be properly cured, bright color, sound, well baled and contain not more than one-twentieth of other grasses.

FIG. 90.—Small, medium and large bales, end view; New England and other eastern markets prefer large bales; southwestern markets prefer small bales 14 by 16 inches; central western markets prefer medium bales, 17 by 22 inches. (U. S. D. A.)

No. 1 may have one-eighth of other grasses or clover and is otherwise like the choice grade. No. 2 is lower in most respects and may contain one-fourth mixtures. No. 3 is still poorer.

Selling Hay.—Farmers who grow hay for market have a greater difficulty now than formerly because of the scarcity of horses in cities. When horses were more abundantly used in cities the farmers and dealers shipped baled hay in large quantities to central markets.

Finding markets for hay requires planning in advance. Contracts can be made with users of large numbers of mules and horses. Often such work animals are used around mining camps, where roads are being graded, and where logging or lumbering is in progress. By looking ahead the owners of hay may find suitable markets.

In present-day marketing of hay the dealers and owners often

find it necessary to ship away from rather than to large cities. In such cases it is very important that the grade of hay be established in the locality instead of in the city market. For this reason the classes of hay should be well understood by growers.

Optional Studies.—Most of our cultivated grasses have been introduced from other countries. Look up the origin or the introduction of the leading grasses described.

Surveys, Trips, Exercises, Projects, and Problems

1. **Grass surveys** should include the following points: Areas in pasture; areas for hay; varieties grown; which most successful; number of cuttings of hay per acre, liming; fertilizing; seed crops; seeding methods; hay-making machines; prices for hay; grades produced.

2. **Problems** based upon the survey may be solved with much profit. Make comparisons of yields from different kinds of grass and calculate the percentage values of these. Make percentage ranks, considering timothy or some other leading hay as 100. Compare all yields of the region with the highest one, fixing the percentage yield of each.

3. **Charts.**—Good subjects for charts are given: Qualities of a good pasture grass; Qualities of a good hay grass; List of all local grasses in order of importance; Methods of maintaining pastures; Advantages of mixtures. (Fig. 91.)

Comparative Values of Grasses

Name of feed.	Dry matter in 100 lbs.	Digestible parts in 100 lbs.		Fertility in 1000 lbs.		
		Protein	Carbohydrates (+ fat × 2.25)	Nitrogen (N)	Phosphoric acid (P_2O_5)	Potash (K_2O)
Brome grass, smooth	85.7	6.6	47.9	....	...	....
Bermuda grass	92.9	6.4	48.5	17.1	...	...
Kentucky blue-grass, hay	86.0	4.4	41.8	12.5	4.0	15.7
Kentucky blue-grass, green	34.9	2.8	21.5	6.6	...	....
Meadow fescue	80.0	4.2	40.3	11.2	4.0	21.0
Orchard grass	90.1	4.9	45.6	12.9	3.7	16.9
Prairie hay	90.8	3.0	46.5	9.9	...	....
Red-top, hay	91.1	4.8	49.1	12.6	3.6	10.2
Timothy, green	38.4	1.5	21.2	5.0	2.6	7.6
Timothy, hay	86.8	2.8	45.3	9.4	3.3	14.2

4. **Pictures for placards** may be obtained from implement catalogues, from grass bulletins, seed catalogues and agricultural journals.

Averag Time Required for Development of Grasses.

Name.	Full development years.	Approximate life of good sod.
Bermuda	1–2	Permanent
Brome grasses, smooth	1	Permanent
Canada Blue-grass	3–4	Permanent
Carpet grass	1–2	5–10 years
Johnson grass	...	Permanent
Kentucky Blue-grass	3–4	Permanent
Meadow Fescue	1–2	3–5 years
Orchard grass	1–2	5–10 years
Red-top	2	Permanent
Rye-grass, Italian	¼	1 year
Rye-grass, English	¼	2 years
Sudan grass	¼	1 year
Timothy	2	5–10 years

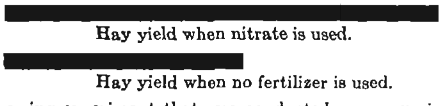
5. **Subjects for Debates.**—"Resolved, that timothy is more valuable than all other grasses combined"; "Resolved, that Johnson grass is more injurious than beneficial"; "Resolved, that grass mixtures are better for pastures than for hay fields"; "Resolved, that permanent pastures are better than temporary pastures"; "Resolved, that dump rakes are better than side-delivery rakes"; "Resolved, that self-feeding balers are most economical."

6. **Field trips** should be taken to study different grasses in pastures and hay fields; to study methods of starting grasses; to study methods of hay making; to study seed harvesting and thrashing; to study markets and grades of hay.

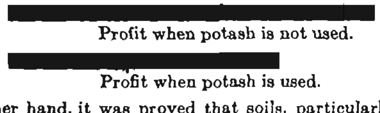
7. **Grass projects** may be with pastures or with hay crops. From five to ten acres of hay will make a good student project, extra labor being employed at hay time. Plan the project beginning with the starting of the field and continuing at least through one year and until after the marketing of the crop.

8. **Project trials** should include: Trials in liming; fertilizing; rejuvenating old fields; different grass mixtures.

Fig. 91.—Top-dressing at a profit and at a loss.



In a Top-dressing experiment that was conducted over a period of nine years the New Hampshire Station proved that a farmer could get a profit of $1.75 per acre by applying 200 lbs. of nitrate of soda to grassland.



On the other hand, it was proved that soils, particularly if of a heavy type, do not need potash for hay. Instead of using the prevalent 5-8-4 fertilizer, the farmer could save $2 an acre by using fertilizer without the potash.

Questions and Investigations

1. Describe and give an example of temporary pasture; permanent pasture.
2. Give six methods of maintaining a permanent pasture.
3. Describe the qualities of a pasture grass. Give arguments in favor of sowing mixtures.
4. Mention the best local pasture grasses. Hay grasses.
5. Mention qualities of a good hay grass.
6. Describe ways of starting timothy. Which are used locally?
7. Give directions for making hay from timothy or local grasses.
8. Discuss the benefits of Kentucky blue-grass. Compare it with Bermuda.
9. Compare orchard grass and red-top.
10. Discuss adaptations and uses of brome grass.
11. Compare Johnson grass with Sudan grass.
12. Describe the saving of grass seed locally or elsewhere.
13. List hay-making machinery and compare different types for the same purpose.

Farm Mechanics.—Make and repair hay rack; seed sieve; seed strippers; seed storage bins. Make holder for lines on hay rack. Repair wagon racks for hauling hay; seed cleaner; baler; rake; mower; loader.

Calculations.—1. At a road camp a young farmer sold 30 tons baled hay at $16 a ton, hauling it only 5 mi. by truck, over a period of two months. The city market price was $1 higher at first but the haul was 6 mi. farther over an incompleted road. Find his receipts in each method of selling.

2. At 10c a mi. each way for a one-ton truck, calculate the cost of delivery of all the hay in each case of problem 1.

3. From the results of problems 1 and 2 calculate the advantage of one plan of selling and delivery over the other.

4. A dairyman maintains a permanent 20-acre pasture by mowing the weeds, reseeding, harrowing, liming, and fertilizing. He finds such care costs, on an average, $28 a year. He was thus able to pasture 20 animals instead of 10 each season for 6 months. The local charge for pasturage is 75c a head by the month. Find his profit due to maintaining a better pasture.

5. Calculate the cost for seeding 20 acres with seed of each of three of the grasses in the table on page 144, using local prices of seed.

6. Calculate the value of seed yielded by each of the same three grasses at local sale prices.

7. By feed table data compare the total feed ingredients in a ton each of three local grasses.

8. Compare three grasses in the total fertility removed from the soil by a ton of each. (See Appendix table.)

ALFALFA ENTERPRISE

Analysis into Jobs.—The main teaching units in the alfalfa enterprise are included in the following list of jobs. References are given to pages in *New Agriculture*, in Montgomery's *Productive Farm Crops*, and to numbers of *U. S. Farmers' Bulletins*. See *Field-Crop Enterprises.*

1. **Deciding whether or not to grow alfalfa,** pp. 149, 150; *Farm Crops*, 378, 382, 384–389; *Bulletins*, 1229, 1283, 1467, 1653. *Local inquiry.*—(*a*) What are the opinions of farmers regarding the growing of alfalfa? (*b*) Ask them to compare it with other hay crops.
2. **Determining acreage, soil, and field,** pp. 16, 39, 149, 157; *Farm Crops*, 382, 389; *Bulletins*, 805, 1496. *Local inquiry.*—(*a*) Find the sizes of fields of alfalfa. (*b*) Compare these with numbers of stock fed. (*c*) What local soils are best for alfalfa? (*d*) After what other crops is alfalfa usually grown? (*e*) Describe the drainage of soils where needed for alfalfa.
3. **Securing improved seed. Choosing variety,** pp. 33, 36, 41, 149, 150, 152, 155; *Farm Crops*, 386, 389; *Bulletins*, 428, 660, 1467. *Local inquiry.*—(*a*) What strains or varieties of alfalfa are grown locally? (*b*) What are the local sources of seed? (*c*) Secure several samples and compare as to quality and purity; germinate these.
4. **Supplying organic matter in the soil,** pp. 46, 49; *Farm Crops*, 390; *Bulletin*, 1250. *Local inquiry.*—(*a*) Find what rotation plans are used to supply organic matter to soils. (*b*) How is green manure produced and used? (*c*) Describe the best local methods in handling the annual manure supply.
5. **Preparing soil. Bare-fallowing,** pp. 40, 50, 51, 152. *Bulletins*, 805, 1606, 1630. *Local inquiry.*—(*a*) How do local farmers prepare soil for alfalfa? (*b*) Ask farmers to give their reasons for and against bare-fallowing.
6. **Fertilizing,** pp. 44, 45, 154; *Farm Crops*, 36, 340, 379, 390. *Local inquiry.*—(*a*) Find what fertilizers are used in growing alfalfa. (*b*) What farmers apply fertilizer before planting? (*c*) Which ones top dress the crop each year?
7. **Liming the soil,** pp. 43, 44, 153, 163; *Farm Crops*, 383, 389; *Bulletin*, 921. *Local inquiry.*—(*a*) What forms of lime are used by local growers? (*b*) Find the rates of application of lime. (*c*) What reasons are given by farmers for and against plowing under lime?
8. **Inoculating the seed,** pp. 51, 52, 151, 152; *Farm Crops*, 380, 381, 390; *Bulletin*, 1496. *Local inquiry.*—(*a*) What methods of inoculation are used by local farmers? (*b*) What other legumes seem to need inoculation in your region? (*c*) Compare the cost of the agglutination method with other methods.
9. **Sowing seed,** pp. 90, 91, 152, 153; *Farm Crops*, 390, 391; *Bulletins*, 1283, 1630. *Local inquiry.*—Describe seeding as practiced by local farmers.
10. **Controlling enemies,** pp. 154, 155; *Farm Crops*, 395; *Bulletins*, 636, 660, 944, 982, 1094, 1528, 1537, 1642. *Local inquiry.*—(*a*) What are the chief alfalfa enemies of your region? (*b*) How do farmers control these?
11. **Cultivating alfalfa,** p. 154; *Farm Crops*, 393; *Bulletins*, 1283, 1630. *Local inquiry.*—(*a*) What implements are used in cultivating alfalfa? (*b*) After what cuttings is cultivating usually done? (*c*) What weeds or grass are most troublesome in alfalfa fields?

12. **Harvesting alfalfa,** pp. 155, 156; *Farm Crops*, 379, 392; *Bulletins*, 1283; 1525, Haying equipment; 1615, Haystackers. *Local inquiry.*—(*a*) How many cuttings a year are made by local growers? (*b*) Which of these cuttings is hardest to cure? (*c*) Describe the best system of hay-making you can find.
13. **Selling and using,** pp. 156, 157; *Farm Crops*, 394, 440, 484; *Bulletins*, 1144, 1229, 1232, 1283, 1539, 1653. *Local inquiry.*—(*a*) What uses are made of alfalfa by local growers? (*b*) Give reasons for local practices regarding the harvesting of alfalfa seed. (*c*) Is alfalfa hay sold coöperatively? Why?
14. **Summarizing the records,** pp. 18, 19; *Bulletins*, 511, 572, 782, 1182. *Local inquiry.*—(*a*) Ask farmers to give cost of each of the jobs in growing alfalfa. (*b*) Ask regarding yields and returns from sales of the seed or of hay or of both.

CHAPTER VIII

ALFALFA ENTERPRISE

NEXT to red clover, alfalfa is the most important member of the legume family of plants. It is gaining rapidly toward first place among the hay crops. Timothy exceeds alfalfa in amount of forage produced annually in America.

Regions for Alfalfa Growing.—The 1920 census shows nearly nine million acres devoted to alfalfa. (Fig. 92.) The four leading states are Kansas, Nebraska, Colorado, and California. In nearly all irrigated regions this crop is grown and often in the unwatered fields near by. In the region of South Dakota, Nebraska, Kansas. Oklahoma, Texas and westward, the crop is one of the most important. There is no state in the Union which does not grow alfalfa to some extent. This could almost be said of every county in the humid area. Every province in Canada has some alfalfa acreage.

Alfalfa of different strains can withstand the extreme summer heat of Arizona and the cold climates of North Dakota and Manitoba.

The crop thrives fairly well in semi-arid climates without irrigation. In tropical and subtropical regions great humidity seems to be detrimental, but the right strains seem to produce abundant crops with much success in Mississippi, Alabama and other Gulf states, where the summers are hot and the climate is humid.

The roots cannot endure flooding for long periods of time. If drainage follows flooding rather promptly the danger is slight.

Soils for Alfalfa.—In choosing a field for alfalfa well-drained, fertile soils, rich in lime, will suit best. Barren soils should first be rebuilt by other methods before growing the crop. The applications of plenty of lime, however, will greatly help. The subsoil should be such as can be penetrated by the roots. Heavy shale or standing water on the surface are both detrimental, but in different ways. The roots penetrate to great depth and the best soils are those which allow such growth. In the semi-arid regions nearly all types of soil may be used.

Strains and Varieties.—Experiment stations have given considerable attention to different strains and varieties of alfalfa, but the ordinary grower secures his seed from his neighbor or from his own field if seed be produced in that section. In non-seed-bearing regions, such as the more humid states, seed is usually

obtained from Kansas or Colorado. This is known as western alfalfa. It has become well acclimatized and suits the moist seasons as well as the dry summers. Grimm alfalfa is well suited to cold regions such as North Dakota and Minnesota. Turkestan alfalfa is somewhat grown in South Dakota and other cold climates. Much Utah grown seed is used in irrigated regions and in the coldest states. All commonly used strains are of one variety, having upright, leafy stems, purple blossoms and deep roots. The stems arise from a

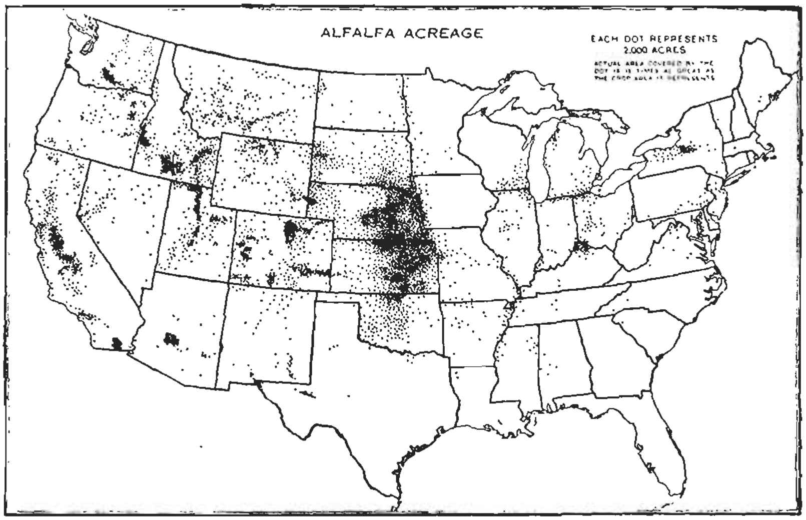


FIG. 92.—Distribution of alfalfa, each dot representing 2000 acres. The crop demands soils that are not acid or soil in regions where lime is available. (U. S. D. A.)

branching crown which produces new buds for each new growth. The various strains differ in habit of growth.

About fifteen other varieties of alfalfa have been identified, but only one besides the common variety is much grown. This is the yellow flowered alfalfa sometimes grown to a limited extent in very cold regions.

Securing Seed.—Be sure of a supply of clean, fresh alfalfa seed. Seed dealers usually supply the best if it is demanded. Examine seed carefully with a hand lens to be sure that there are no weeds such as yellow trefoil, buckhorn or dodder mixed with it. Even a small number of weeds in a sample is cause for rejecting the lot. The crop is not a good weed fighter and no weeds should be sown. Fresh seed will have a bright appearance and be free from any odor of sulfur or other chemicals.

Inoculation of Seed.—In the states east of the Mississippi and somewhat in other regions inoculation with alfalfa bacteria is often necessary if the fields to be grown have not grown the crop recently. Inquiry from county agents and experiment stations will make it easy to decide whether or not inoculation will be necessary.

The benefits resulting from inoculation consist in (1) making the plants able to use nitrogen from the air and store it in their tissues; (2) largely prevent the crop from using nitrogen already in the soil, thus depleting the soil during growth. (Fig. 93.)

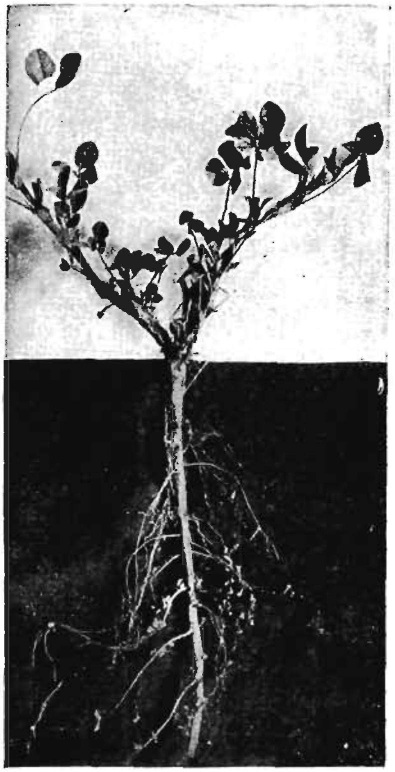


Fig. 93.—Alfalfa plant, showing crown, root system and nodules. The root extends to a depth of many feet. (U. S. D. A.)

Methods of Inoculation.—There are several methods in common use for inoculating legume seeds of any kind: (1) Coating the seeds with the bacteria taken from soils; (2) coating the seeds with bacteria from pure cultures produced in laboratories and purchased from seedsmen; (3) sowing soil from inoculated fields on uninoculated fields just before seeding time: (4) inoculating soil with bacteria from other soil or pure cultures and sowing this on the field; (5) sprinkling water containing the bacteria on growing fields during showers or before rains.

The first method mentioned has been often tested and is coming into general use because of its simplicity. Two main steps are involved: (a) A sample of soil, say one peck, is taken from a field where growth and inoculation are known to be good. One-half the soil is put in a tub of water and stirred for several minutes until plenty of bacteria are washed out of the soil into the water. After a moment of settling the water is poured off into another vessel, leaving the mud behind. Put a little liquid glue and a

handful of lime in this water and stir well. This water is sprinkled over the mass of seeds to be inoculated. Stir the seeds while sprinkling until all are wet.

(b) The other half of the soil should be sifted to remove trash. Sprinkle it over the wet seed and stir in thoroughly until all the seeds have some soil adhering to them. This second step is not always taken for fear of introducing new weed seeds. But it is of much help in the inoculation.

Use of pure cultures should be recommended only for regions where a good sample of alfalfa soil cannot readily be secured within easy shipping distance. Pure cultures often fail because of being old or because of being handled improperly. Experimental tests made with pure cultures have shown that under ordinary conditions they fail in about 90 per cent of all trials. Pure cultures cost about one to two dollars per acre while soil samples are freely supplied by growers.

The third method above listed of spreading inoculated soil on fields before sowing is very laborious as several hundred pounds per acre are necessary to secure good results. This method has been much used and is very successful if the newly spread soil is harrowed into the seed bed before the sun shines upon it. There is danger of introducing new weed seeds in this way. Methods No. 4 and 5 are never used except in cases of extreme emergency.

Time of Seeding.—In the regions east of the Mississippi and in some other sections, particularly the more humid ones, seeding is usually done in early fall or late summer, August being the most popular month. The new crops will thus not suffer from hot summer drouths until the roots have penetrated to considerable depth. Also, weeds are less likely to compete with the young crop than if started in the spring.

Spring seeding is the best in the drier parts of Kansas, Nebraska, and other states where the crop is extensively grown. Spring sowing is done in grain but is better alone.

Preparation of Soil for Alfalfa.—For August sowing it is best to plan the crops so that a period of six weeks in mid-summer may be used as a bare-fallow period. If an early potato crop or a spring grain crop has been harvested the ground should be plowed and disked immediately. If heavy rains occur, which tend to beat the soil together, harrowing should follow each. The last harrowing should be made just before seed is sown. Moisture is well conserved by this plan and weed seeds are thoroughly sprouted and killed in all the layers near the surface.

Liming for Alfalfa.—The crop requires lime for its successful growth. *Soil samples from the field may be tested to determine* the needs of lime. The litmus test, while indicative, is not definite enough. *The Truog test should be used in all cases where there* is any doubt as to the need of lime.

In most soils of humid regions lime has been washed from the surface soil and new applications will benefit the crop. Many soils of dry regions are never limed for alfalfa.

Rates of liming depend upon the kind of lime and the character of soil. If the Truog test has been used it will indicate pretty clearly the amount of lime needed per acre. Always apply the lime on the seed bed and never plow it under. Harrowing or disking is sufficient to mix the lime with the soil. This may be done just before seeding. If fresh-burned lime, which is the most concentrated form, be used it may be hauled to the field and left in piles to air-slack. A little water on each pile will hasten the slacking or crumbling. It may then be spread with shovels or, better, with lime spreaders, fertilizer spreaders or manure spreaders. One or two tons per acre of this usually give excellent results.

If crushed limestone in the fine powdered form be used it is spread by any of the above-mentioned methods evenly over the seed bed and may be harrowed in when seed is being covered. This should be applied at double the rates used for burned lime. Its effects are slower and last longer.

Seeding Alfalfa.—When seed is sown in grain fields broadcast methods are used. Harrowing or rolling the field will help cover the seed. Special grass seed or alfalfa boxes are often attached to grain drills so the seed may be drilled behind the grain. If the crop is to be seeded alone as is usually the case for August and September sowing either drilling or broadcasting may be followed. The wheelbarrow seeder is popular in some sections because it covers a large area in a short time and makes an even distribution of the seed. It is a good practice to sow half the seed in one direction, say east and west, and the other half crosswise of this to avoid bare spots and have a more even stand throughout the field. Seed may be covered with a harrow as it should not be very deep. If the seed bed be moist and if rain falls soon after seeding, results are likely to be very satisfactory.

Rates of seeding differ in different states. Where weeds are bad, as in the humid sections, more seeds are used than in drier climates. Twenty or thirty pounds per acre are often sown, fifteen to twenty-five pounds in drier climates.

Cultivation of alfalfa is not practised in regions of greatest production. In the dry limits of growth of the crop it is sometimes drilled in rows far enough apart for some intertillage. In humid climates where weeds and grass seriously compete with the crop, disk harrows or special alfalfa cultivators are run over the field about once each summer, after the third or fourth cutting. Such tillage aids in controlling crab grass and other weeds and improves the stand of alfalfa.

Fertilizing.—Alfalfa fields are often improved by a top dressing with barnyard manure. In doing this use well-rotted manure to avoid the introduction of weeds. Commercial fertilizers are seldom used in growing alfalfa, but when used should consist chiefly of considerable phosphate and some potash. These may be applied when the seed bed is prepared by top dressing. Top

Fig. 94.—The "Rocky Mountain" locust (left) and the "lesser locust" (right) are two of the most destructive of the grasshoppers. The former has wrought destruction in the western states several times. The latter is often very injurious to alfalfa, clover and other crops in eastern states. (Economic Entomology.)

dressing with lime after the growth is a few years old is often practised with much benefit in humid (not dry) climates.

Irrigation.—Where the crop is grown under irrigation care is necessary to avoid drowning the roots, particularly where subsoils are heavy. Too much water may bring alkali deposits to the surface. The rule should be to irrigate with as little water as possible. The best time to apply it is just after each crop of hay is removed. The water will stimulate the next growth.

Enemies.—Grasshoppers or locusts often attack alfalfa. (Fig. 94.) Turkeys in the field will eventually capture most of these insects. Disking in early spring on fields where grasshoppers were serious the preceding year will destroy young egg masses or expose them to the attacks of birds and poultry. Cutting the crop will sometimes cause the grasshoppers to move to other fields or will aid turkeys in controlling them.

Blister beetles are sometimes abundant enough to do some damage. Mowing the field is probably the best remedy.

In western states prairie dogs, gophers and meadow mice often do considerable damage to the roots of alfalfa. Poisoning with strichnine on potatoes or leaves scattered on the field is recommended. Carbon bisulfid is effectually used to kill them in their burrows. A little liquid is poured in each burrow and the opening is then covered with soil or in some other manner.

Diseases of several kinds attack alfalfa in some sections, leaf-rust, leaf spots, mildews and root-rot. Spraying methods of controlling fungous

diseases are not practical in alfalfa fields. Frequent mowing and stimulating growth by the use of lime and fertilizers are the best remedies for diseases which attack the leaves and stems. Rotation of crops is recommended for root-rot, using crops in the rotation which will not act as hosts to the disease, such as corn and small grains.

Hay Making.—The grower should watch for three conditions, any one of which is an indication that the crop should be cut: (1) If the leaves turn yellow from lack of moisture or from any disease; (2) when the crop begins to blossom or is about one-third in blossom; (3) when the buds at the crown begin to form shoots.

The number of cuttings per year in central and southern sections is four or five. Farther north three or four cuttings per season are more common. When the moisture supply is low the number of cuttings may be reduced. This is not helpful to the plant.

In humid climates drouth periods may injure the stand unless cuttings are continued in spite of the slow growth.

For the best quality of hay each cutting should be made rather early in the stage of growth. If the growth stands too long the stems become woody, coarse and less palatable and the effect on the next growth is often detrimental, but not so in all regions.

When the nature of alfalfa is understood by the farmer it is the easiest crop to cure. The stems are not hollow and the plants do not absorb water readily. In dry climates hay curing is not difficult, but in moist climates the early cuttings are very difficult to cure because of frequent rains. One of the best methods is here given: Cut the crop after the morning dew is gone. Allow the crop to lie in swath until afternoon of the next day, then rake it into windrows and put it into small, slender shocks. By the middle of the next day it should be ready to haul to the hay mow. In case of rains the crop suffers less with the hay in swath than it does in windrows or shocks. The use of hay caps on shocks may be resorted to, but is an expensive method. Figures 95, 96 and 97 show good hay-making equipment.

Harvesting Seed.—The production of alfalfa seed is restricted to rather dry climates. The blossoms are not abundantly pollinated in humid regions. Alfalfa stands for seed production should be rather thin for the free circulation of air between the plants. The second or third growth is best to save for seed except in northern states where the first crop is better. The crop is cut when the pods are about three-fourths brown. Delay will cause shattering of seed. To avoid too much handling a self-rake reaper is often employed, but cutting with mowers and raking the crop is more common. Thrashing is usually done from the shocks with-

out stacking. Yields average four or five bushels per acre. Extreme yields have reached twenty bushels.

Marketing Alfalfa Hay.—Much of the alfalfa grown in the West is shipped to eastern markets. It is graded according to brightness in color, leafiness of stems, freedom from weeds and grass mixtures and freedom from mold or rot. The grades correspond to those for timothy. (Chap. VII.)

Alfalfa Meal.—At central markets or in alfalfa-growing regions of the West much alfalfa meal is produced by grinding the entire hay. This product is usually marketed in hundred-pound sacks for feeding dairy cows and other livestock. Dry mash mixtures for

FIG. 95.—A side delivery hay rake rolls the hay into a wind row at one side. (I. H. Co.)

poultry often contain some alfalfa meal. Feed mixers often add to this meal small quantities of grain and molasses with considerable water in preparing feeds for livestock. The purchase of such a mixture, however, is usually not economical.

Alfalfa as Pasture.—The crowns of alfalfa plants are supplied with buds to produce the new growth. Pasturing tends to injure these buds. The result may be to greatly reduce the stand. From the standpoint of the livestock, however, no better pasture is grown. The following rules should be observed somewhat closely: (1) Let the stand become well established before pasturing; (2) use large areas and few animals to avoid pasturing too closely; (3) avoid pasturing in muddy weather; (4) clip alfalfa fields to keep the growth even; (5) watch for bloating among animals.

Feeding Value of Alfalfa.—The high nutritive value of alfalfa makes it comparable, ton for ton, with wheat bran and with middlings. It contains over 10 per cent digestible protein and 40 per cent of carbohydrates and fats. It is one of the richest

crops in mineral content. A little over half of the alfalfa plant is in the hay and a little less than half in the stubble and roots. Of the part used for hay the stems of western alfalfa average 55 per cent and the leaves 45 per cent. Fine-stemmed alfalfa grown in moister climates has more leaf and less stem.

Other Valuable Features of Alfalfa.—Yields of cured hay

FIG. 96.—The hay loader saves the work of two men. (I. H. Co.)

average from three to five tons per acre annually. This is several times greater than the yields from clover or timothy.

The crop resists drouth well and lasts many years. We have few crops that meet these conditions.

Rotations.—As alfalfa roots penetrate to a great depth and leave a large supply of organic matter and nitrogen in the soil, other crops, such as corn, kafir, and sorghum thrive well when following alfalfa. As alfalfa usually stands a number of years the interval between its crops should be rather short. A good plan is to make the spring cutting in time to plow the stubble and plant corn. Clean cultivation in the corn will control most of the bad weeds. Winter grain may be sown after the corn and when this crop is cut the soil is prepared for alfalfa to be sown the next August.

Related Legumes

Black medic or yellow trefoil resembles alfalfa in form and appearance but is much smaller. It is not often grown with profit in America. The seed is often found mixed with foreign alfalfa seed. The flowers are yellow and the plant is, therefore, often

confused with yellow suckling clover and hop clover. Its presence is not desirable in alfalfa fields as the yields are much reduced.

Burr-clover or spotted medic is grown as a winter annual in warm climates, as in the Gulf states. The bacteria on its roots are believed to be interchangeable with those on alfalfa roots. The habit of growth of the plant is similar to alfalfa. The seeds resemble alfalfa but are borne in toothed or burred pods. It is good to use as a winter cover crop and pasture. Its use as a soil builder should

FIG. 97.—Stacking alfalfa in the open field. Hay is brought to the stack with sweep rakes called "go-devils" and is lifted with a crane stacker. (I. H. Co.)

be encouraged in the South. Thirty or more pounds of seed per acre are sown in early fall.

Sweet clover or mellilotus is a biennial producing no blossoms the first year but producing blossoms and seed the second year and then dying. An annual form, called Hubam, has recently been developed in Iowa, which bears blossoms and seed the first year. The claims for its advantage have been widely heralded and considerably exaggerated. The common form is grown in all states and in Canada. It is well adapted to rocky places where other crops will not thrive, particularly if the rocks are limestone. An abundance of lime in any soil will greatly improve the yields. Seedings are made about as for alfalfa. Two cuttings of hay are usually secured the second season, or with the annual form, one cutting the first season. The bitter taste in the plants causes animals to avoid eating it until they have been induced to like it. The stems become very woody, which makes the crop hard to cure and less palatable. Its chief advantage lies in its endurance of soils unsuited to the growth of alfalfa.

Optional Studies.—Alfalfa probably was first used by civilized man in Media or Persia, thence it was taken to Greece and later to Rome and other European countries. Its introduction into France and Germany is recorded as occurring in the sixteenth century. American colonists attempted to grow it, but with little success. The first rapid development was in California after 1850, being introduced from Chile.

The name alfalfa is of Arabian origin. This name is chiefly used in America, but in other countries *lucerne* is a more common name for the plant. The name purple media preceded the name lucerne.

Surveys, Trips, Exercises, Projects, and Problems

1. **Alfalfa Survey.**—Include in a local survey such topics as the following: Acres in alfalfa; age of oldest stands; alfalfa rotations; preparation of soil; time and rate of seeding; inoculation; liming; source of seed; enemies; pasturing; damage, if any; number of cuttings per year; yields; cost of production; baling; grades produced; marketing; uses.

2. **Problems** from the survey and from the last census report may be readily made to develop the importance of the crop and its relation to the farming system in the county, the state and the nation. Compare costs of protein in this form with that purchased in bran.

3. **Alfalfa charts** may be made on these topics: Steps in inoculation; benefits of inoculation; benefits of liming; steps in Truog test; steps in hay making; enemies and remedies; necessary steps for succeeding with alfalfa.

4. **Alfalfa pictures** for placards may be collected and mounted for use in class rooms, in homes and in public meetings. Get pictures of alfalfa machinery including lime crushers; field operations; bad weed seeds; inoculation.

5. **Debates.**—"Alfalfa vs. other hay crops," "Liming or no liming," "Inoculation or not," "Spring or fall seeding," "Growing with or without nurse crops."

6. **Field Trips.**—Study soil preparation, seeding, liming. Determine time of seeding, hay making and baling. Visit grinding mills, feed mixers, and see the use of alfalfa in various forms in feed lots and barns.

7. **Alfalfa projects** should begin with soil preparation through all the steps until the first year's cuttings are marketed or ready for use. About five acres is a good area for a student project. Include all necessary steps for best success and plan the studies to correspond to each step.

8. **Trials with projects** should compare liming with no liming; bare-fallow and not; inoculation and none; two methods of inoculation; seed from different sources; different rates of seeding.

9. **Exercises.**—(a) In the laboratory inoculate seed by method No. 1 described in this chapter. This is known as the agglutination method. (b) Grow inoculated seed in window boxes of soil. Dig up some plants carefully and examine for nodules each week after the second. How soon do they first appear? (c) Examine several different lots of alfalfa seed under a lens for impurities, determine percentages. (d) In a field examine alfalfa crowns counting numbers of stems from single crowns and numbers of buds. (e) Dig roots, carefully rinse in water, and locate nodules; compare numbers of nodules on good and poor patches. (f) If possible determine the depth of alfalfa roots.

Questions and Investigations

1. About how does your state rank in alfalfa growing? If high or low give reason.
2. Discuss soils for alfalfa.
3. What strains are grown in your state?
4. Describe inoculation.

5. Compare spring with August seeding. Give local dates.
6. Describe preparation of soil and liming.
7. Give rates of seeding and rates of liming.
8. Why should alfalfa be cultivated? How? When?
9. What enemies of the crop are serious in your region? Give control methods.
10. Describe a good method of making alfalfa hay.
11. Discuss the pasturing of alfalfa.
12. Give good alfalfa rotations.
13. Discuss the feeding value of alfalfa. What is alfalfa meal?
14. Discuss the adaptation and uses of burr-clover. Of sweet clover.

Farm Mechanics.—Make or repair lime spreader; sweep rake; lifting crane; seed scarifier. Repair mowers; rake; loader; grinder; baler.

Calculations.—1. A student inoculated seed for a 20-acre field by the agglutination method at a total cost for labor and materials, of $1. His neighbor bought artificial culture at a seed store, at a cost of $1 per acre and paid $1 for labor in treating the seed for 20 acres. Calculate the cost per bu. in each case if each sows 20 lb. per acre.

2. Find the protein yields per acre from timothy and alfalfa (see feed tables), if the yields of hay are 2 tons and 4 tons, respectively.

3. Calculate the above yields of protein in terms of the protein in a ton of wheat bran (see feed table).

4. Calculate the total yields of protein per acre from sweet clover yielding 3 tons of cured hay. Express this also in terms of the protein in a ton of wheat bran.

5. Find the costs for seed to sow an acre each of these three crops, at local prices for seed if the pounds sown are alfalfa 20, sweet clover 20, timothy 5.

6. The above three crops yield cuttings for the following numbers of years:

Alfalfa, 4 years—4 tons per year.
Sweet clover, 1 year—3 tons.
Timothy, 1 year—2 tons.

Find the seed cost per ton of hay produced, of each kind.

THE TRUE CLOVERS

Analysis into Jobs.—*The following jobs include the growing of* Red Clover, Alsike Clover, Mammoth Clover, White Clover and Crimson Clover. These are treated together because of their natural relationships. The references are to pages in *New Agriculture,* Davis' *Farm Projects and Problems,* Montgomery's *Farm Crops,* and to *U. S. Farmers' Bulletins.* See *Field-Crop Enterprises* and *Southern Field-Crop Enterprises.*

1. **Deciding whether or not to grow a clover crop,** pp. 161, 170; *Farm Projects,* 154; *Farm Crops,* 398; *Bulletin,* 1339. *Local inquiry.*—(*a*) Ask farmers regarding their successes and failures with clover. (*b*) Try to find the causes of failures that have occurred. (*c*) Compare local yields with state averages. (*d*) Study local prices and uses of the crop. (*e*) Find the nearest sources of lime and prices of the same.
2. **Choosing the type of clover to grow,** pp. 161, 163, 164, 166; *Farm Projects,* 154–156; *Farm Crops,* 418; *Bulletins,* 1151, 1339, 1511. *Local inquiry.*—(*a*) Make a list of the clovers grown locally. (*b*) See which of these are most popular and why. (*c*) Compare the yields of hay and seed obtained from each. (*d*) Draw your conclusions regarding the best clovers to grow.
3. **Choosing the soil and field. Deciding acreage,** pp. 34, 39, 86, 133, 134, 161, 163, 166; *Farm Projects,* 156–158; *Farm Crops,* 398–418; *Bulletins,* 921, 1250, 1339, 1475. *Local inquiry.*—(*a*) What local soils are considered best for the different clovers? (*b*) What sizes of clover fields are grown? (*c*) What rotations are followed involving clover?
4. **Securing good seed; cleaning and testing,** pp. 32, 33, 36, 66, 161, 166, 472, 474; *Farm Projects,* 158, 163; *Farm Crops,* 401, 402; *Bulletins,* 428, 1542. *Local inquiry.*—(*a*) How do farmers secure their clover seed? (*b*) Who cleans the seed used locally? (*c*) Study the different kinds of weeds found in clover fields and show the relation of their presence to the job of cleaning seed—before selling, before sowing. (*d*) Find how many farmers test seed and how they do it and what they think of it.
5. **Buying and mixing fertilizers,** pp. 27, 44, 45, 69, 70, 168; *Farm Projects,* 158, 159; *Farm Crops,* 402. *Local inquiry.*—(*a*) What fertilizers are purchased for the growing of clover? (*b*) In what other ways is the soil fertility maintained.
6. **Preparing the field for sowing,** pp. 40–42, 50, 70, 161, 165; *Farm Projects,* 160; *Bulletins,* 660, 1151, 1365. *Local inquiry.*—(*a*) Find how many farmers prepare the soil especially for the seeding of clover. (*b*) For which types of clover. (*c*) When clover follows small grain in the rotation, find how many farmers harrow the grain before sowing clover seed.
7. **Liming the field,** pp. 43, 44, 161, 163, 166, 168; *Farm Projects,* 159; *Farm Crops,* 382, 383; *Bulletins,* 921, 1151, 1339, 1365. *Local inquiry.*—(*a*) Find the quantities and types of lime used by local farmers. (*b*) Find the source and cost of lime. (*c*) When is lime applied for clover by local growers? (*d*) Ask farmers which of the clovers require the most lime. (*e*) Get their opinions as to the benefits of liming.
8. **Inoculating the seed,** pp. 51, 54, 151, 166; *Farm Projects,* 158; *Farm Crops,* 381, 382, 413; *Bulletins,* 1339, 1365, 1496. *Local inquiry.*—(*a*) Ask farmers regarding the method of inoculation followed. (*b*) Ask which clovers need inoculation locally. (*c*) Describe the agglutination method (page 151) to one or two farmers and get their reaction regarding the labor *versus* the results.

9. **Sowing and fertilizing**, pp. 70–72, 161, 162, 164, 165, 167; *Farm Projects*, 160; *Farm Crops*, 400–402, 408, 412, 414; *Bulletins*, 921, 1151, 1339, 1365. *Local inquiry.*—(*a*) Find several methods used in sowing clovers that are practiced in your region. (*b*) Find the quantities of seed used for each type of clover. (*c*) Find the time for sowing alone; with other crops.
10. **Caring for and cultivating; pasturing**, pp. 161, 166, 331, 358; *Farm Projects*, 157, 160, 161; *Farm Crops*, 402, 408, 409, 413, 415; *Bulletins*, 660, 921, 1151, 1307, 1339, 1365, 1475, 1573. *Local inquiry.*—(*a*) Ask regarding practice of clipping clover after the cutting of the nurse crop. (*b*) Ask regarding the pasturing of clover after the grain is cut. (*c*) See if crimson clover or other clovers are grown alone, find when and how they are pastured. (*d*) Get the opinions of farmers regarding the closeness of pasturing clover. (*e*) How many farmers practice top-dressing with manure? With lime? With fertilizers?
11. **Controlling enemies**, p. 162; *Farm Crops*, 405, 406; *Bulletins*, 660, 747, 940, 971, 982, 1151, 1307, 1339, 1365, 1414, 1484, 1510, 1537. *Local inquiry.*—(*a*) What insects are found to be injurious to clover locally? (*b*) How are these controlled? (*c*) What diseases seriously injure clover crops? (*d*) How are they controlled? (*e*) What burrowing animals injure clover?
12. **Harvesting and curing hay**, pp. 156–158, 162, 164, 166; *Farm Projects*, 161, 162, 403, 404; *Bulletins*, 1151, Alsike; 1339, Red clover; 1365, 1525, 1615. *Local inquiry.*—(*a*) At what stage of maturity is clover cut for hay by local farmers? (*b*) Ask farmers what preparations they make for the haying season. (*c*) Describe the most rapid and the slowest methods of curing clover. (*d*) Describe local methods of handling hay in the fields.
13. **Harvesting seed and thrashing**, pp. 143, 155, 161, 162, 166; *Farm Projects*, 162, 163; *Farm Crops*, 404, 405, 413, 415; *Bulletins*, 660, 676, 1151, 1339, 1365, 1537, 1542. *Local inquiry.*—(*a*) How do farmers judge maturity of clover to be cut for seed? (*b*) Describe machinery used for crimson clover; for other clovers. (*c*) In what condition of the clover do farmers thrash? (*d*) How do they handle the crop before thrashing?
14. **Feeding and using the crop**, pp. 168, 357, 468, 469; *Farm Projects*, 161; *Farm Crops*, 404, 413, 415, 417; *Bulletins*, 1151, 1250, 1339, 1573. *Local inquiry.*—(*a*) Find what proportion of the clover crops are fed on local farms. (*b*) What farmers turn under crimson clover or the second growth of other clovers for manure? (*c*) Describe racks used in feeding clover hay to loose livestock. (*d*) Ask farmers regarding the losses in feeding clover hay. (*e*) Get opinions regarding clover hay for horses; for other livestock.
15. **Baling and marketing**, p. 145; *Farm Projects*, 163; *Bulletins*, 1144, 1151, 1339, 1525, 1573. *Local inquiry.*—(*a*) Learn the quantities of clover hay sold annually. (*b*) Where are the best hay markets? (*c*) What grades of hay are produced? (*d*) What sizes of bales are made? (*e*) What prices are received for clover hay? (*f*) Get opinions of farmers regarding advisability of holding hay for better prices. (*g*) What are the months of high prices; low prices?
16. **Keeping records**, pp. 18, 19; *Farm Projects*, 32, 35, 78, 79; *Bulletins*, 511, 572, 1139, 1182. *Local inquiry.*—(*a*) Make a list of the cost items in clover growing and marketing. (*b*) Ask several growers regarding the cost of each of these jobs. (*c*) Find the income from local clover crops. (*d*) Calculate the net returns from clover in several cases.

CHAPTER IX

GROWING THE TRUE CLOVERS

LEGUMES are among the most valuable of all families of plants. It has been known for centuries that they are soil builders. The means by which they build soils has been recently determined. Their power to take nitrogen from the air when properly inoculated, store this nitrogen in their tissues, and upon decay return the nitrogen to the soil for the use of other crops, makes them invaluable in all systems of permanent agriculture. Their high content of protein makes them especially valuable for feeding livestock.

Red clover is particularly well adapted to the humid parts of the United States where the climate is not too hot, as north of the Ohio River and east of the Missouri. Probably twenty-five to thirty million acres of red clover are grown in that region either alone or mixed with timothy and other grasses. (Fig. 98.)

Soils.—It thrives on medium loams and other fertile soils, but if well supplied with lime it will succeed on a wide range of soils. (Figs. 99 and 102.) Poor soils are usually much improved by the use of phosphate applied either at seeding time or after the crop is growing.

The seed bed should be well prepared as the seeds are small and should be covered very little. Cloddy fields should be planked, rolled, or otherwise fined and levelled before seeding.

Seeding Clover.—The crop is most commonly seeded in small grain either in fall or very early spring. If mixed with timothy or other grass seeds the two are often sown together. In the North Atlantic states it is not uncommon to find many farmers sowing clover or mixtures with grasses in August without a grain crop. Better stands are thus secured as the soil may be better prepared. Cuttings are made the following summer.

Most farmers use home-grown seeds, which should always be thoroughly recleaned to remove weed seed. About six pounds to the acre are used in mixtures and ten or twelve pounds when sown alone.

Clover Rotations.—Because of the value of this crop in improvement of soils, and because of its short life, two years, it is one of the most popular crops in America in planning rotations. Throughout the clover territory the most common three-year rotation is (1) small grain, (2) clover, (3) corn.

The most common four-year rotation is (1) small grain, (2) clover sown with timothy, (3) timothy hay, (4) corn.

Enemies.—Because of the usual practice of growing clover in rather quick rotations, few enemies are found that have become very serious. "Clover sickness" is really a disease brought on by continuous use of the crop without liming or other soil treatments. Use heavy applications of lime and fertilizer and grow some other legume in the rotation until clover will succeed.

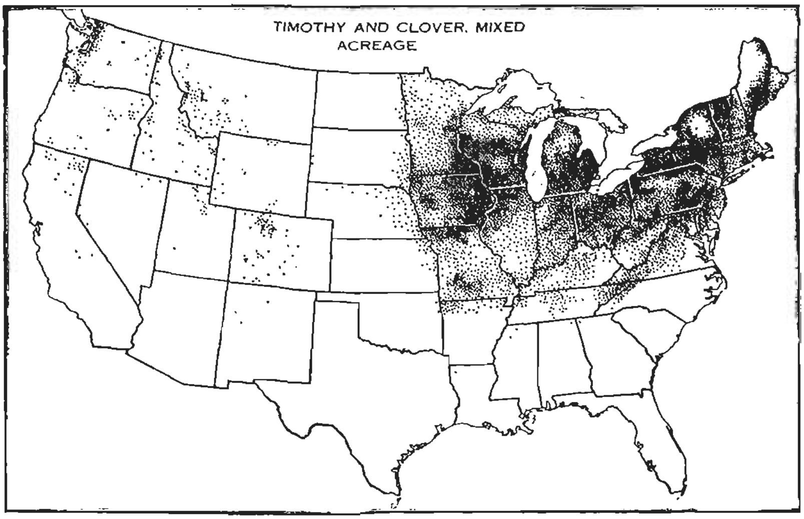


FIG. 98.—Acreage of the mixed crop of timothy and clover, each dot 2,000 acres. (U. S. D. A.)

Hay Making.—When the crop is sown in small grain the clover plants make very little growth until after the grain is harvested. Then the field is well covered with clover which may be pastured a little that fall, but should not be cut for hay. The following summer the first cutting is made about June, when the crop is in full bloom or some of the heads have turned brown. This is the heaviest crop and contains very little, if any, seeds. The second cutting is made about two months later and is often used for hay. If a seed crop is to be saved the second growth is allowed to ripen until all the heads are brown, then it is mowed, raked, shocked and thrashed. Clover hullers (Fig. 100) may be either ordinary grain thrashers or smaller thrashers, having smaller concaves and finer sieves.

Methods of curing clover hay or its mixtures are similar to those already described for timothy and alfalfa. (Chap. VII, VIII.)

If not plowed, some clover will still be found in the field for the second year's crop. But if timothy had been sown with it at seeding time this would constitute most of the crop that season.

Mammoth red clover is really a variety of common red clover. The chief differences between the two plants are given: (1) Mammoth clover, sometimes called sapling clover, is larger than red. (2) The stems are usually hollow instead of solid. (3) It ordinarily furnishes only one cutting a year, which forms seed if allowed to do so. (4) It will produce a crop on rather poor or

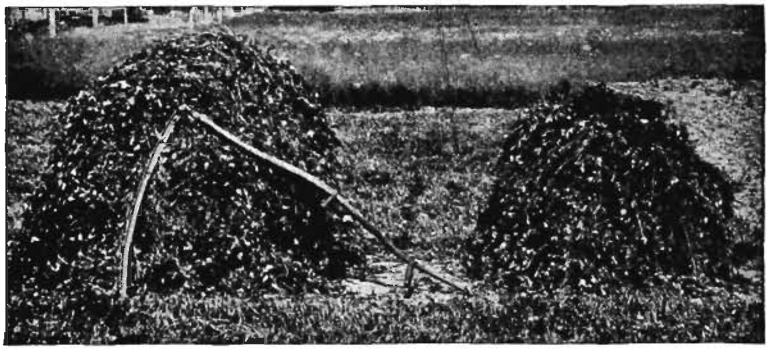


FIG. 99.—Comparative yields from limed and unlimed plots of clover. Liming increases yields of many legumes. (U. S. D. A.)

an acid soil. (5) It generally lives longer. (6) It matures more nearly at the same time as timothy.

Alsike clover has several characteristics midway between red clover and the low white clover. The blossoms are pink and midway in size. In fineness it holds a medium position. Linnæus must have thought it a natural hybrid between these clovers, for he named it hybridum.

Advantages.—Alsike clover is used both for hay and for pasture. It may be grown very successfully on soils which do not have enough lime for the growth of red clover. Its shallower roots adapt it well to undrained fields. Alsike clover grows on poorer soils and on dryer soils than red or mammoth clover. It blossoms and forms seeds the first year. The first cutting is heavy and the second comparatively light. The blossom tubes in the head are so shallow that common honey bees visit them abundantly. Seed is therefore formed in the first growth. The seed crop is usually a profitable one. Beekeepers grow the crop for honey production.

As pasture for livestock it is less creeping than white clover but produces more growth for the first few years, living from three

to five years. If allowed to do so it readily reseeds itself. If allowed to form seed in pastures it is, like white clover, likely to produce considerable slobbering among horses and mules, and sometimes causes eruptions of the skin and mouth. If pastured closely and if used for hay this trouble is not found.

Culture.—Alsike clover is seeded in much the same way as red clover but is more commonly used on fields where red clover does not succeed well. Only four to six pounds of seed are used per acre when it is sown with timothy or other grass seeds. The sowing

FIG. 100.—Hulling red clover seed. The second cutting of the season is used for seed because pollination by bumble-bees is more abundant during the last half of the summer.

may be in either grain fields or in specially prepared soil. It is cut for hay when the timothy is just in blossom or soon after. The crop is then in its most perfect stage for hay. In this respect it is better for mixing with timothy than is red clover. Because of its longer life, it is more popular in the grain belt for four-year rotations than is red clover. The chief objection to alsike clover is its low yield and its decumbent growth.

Crimson clover (Fig. 101) is a winter annual clover much used as a winter cover crop because of its ability to make considerable growth during the cold weather of fall, winter, and spring. For this reason it is particularly well adapted to sea coasts, both east and west, and to the southern states. It is an excellent crop to grow for the production of green manure for the rejuvenation of soils. It produces excellent winter pastures. For this purpose it is often mixed with winter grain such as rye. As a hay crop it is very productive and is much used for cattle. As the heads are very fuzzy it should not be used for long feeding periods for horses and mules.

Culture.—For best success as a winter annual, crimson clover should be sown in late summer or early fall. August is a good time if the soil is moist enough for continuous growth after germination. Many times the young crop is killed by insufficient moisture after germination. It is therefore less suited to growth in corn fields than was formerly supposed. If sown alone, either in cotton fields or open fields, about twelve to fifteen or more pounds of seed

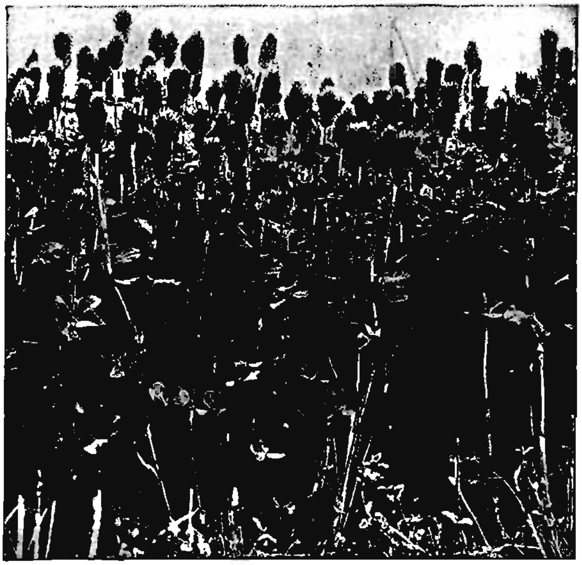


FIG. 101.—Crimson clover is a good winter annual for green manure, winter pasture, and to use as a cover crop.

per acre should be used and the covering should be very slight. Too deep covering often causes failure. In cotton, corn, and tobacco fields a light cultivation between the rows is made just before seeding. The seeds are then sown broadcast and rains are allowed to cover them in the loose soil. Sometimes a light brush is drawn over the field. When sown in open fields, the surface should be well prepared by disking and harrowing and the broadcasted seed should be harrowed lightly or rolled with a rough roller.

During the late fall and winter when the soil is not too muddy, horses, cattle, sheep, and swine may be pastured upon the field if desired. An abundance of good pasturage is furnished if not grazed too closely.

For green manure purposes, whether grown alone or with winter grain, it should be plowed under before the stems begin to form

heads too much. Otherwise a dense mass of organic matter will be left under the furrow slices which will retard capillary movement of soil moisture. This plowing should be done early enough to allow a little time for the soil to settle and for the organic matter to begin to decay. Disking before or after plowing will aid greatly in mixing the organic matter with the soil.

Cutting for hay should be in the blossom stage when a few of the heads have begun to turn brown.

The seed crop is produced by allowing all the heads to turn brown and then cutting the crop with special machines for the

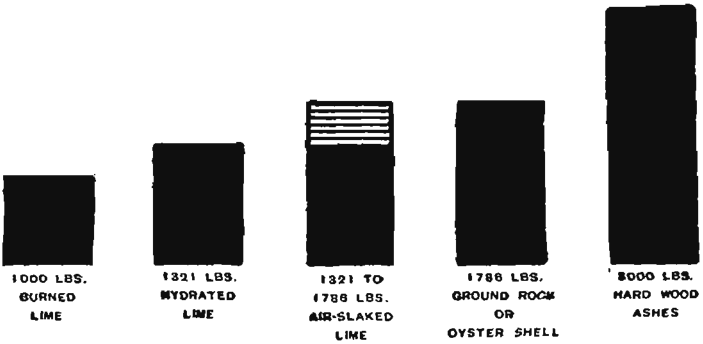


FIG. 102.—Equivalents in different forms of lime. When lime is used on garden soils, it is best not to grow potatoes or other root crops there until a year or two afterward because of the danger of *scab disease*. The danger is least when the ground rock is used.

purpose. The old-style grain reapers with the sickle-bar raised as high as possible serve the purpose well. The heads must be harvested without much of the leafy growth being present. Otherwise they will not cure, but may mold. The seed is thrashed in the same way as red clover.

Seed for the American crop is now produced mainly in Tennessee. It was formerly imported from Europe.

White clover (Fig. 103) is a low trailing plant with slender underground root stalks and surface stems which take root at the nodes. It is chiefly used for pasturage and is seldom cut for hay. Its root system is very shallow, which adapts the plant to very poorly drained places. It is, however, used in all kinds of soils and is a good soil builder. Inoculation is seldom necessary as soil usually contains its bacteria. Lime is very beneficial to white clover. It is a perennial and lives for many years in pastures, being often mixed with blue-grass and Bermuda grass. Livestock

love the fine stems and leaves. When seeds are allowed to mature in pastures they tend to cause horses to slobber severely.

Seed is seldom sown alone. In mixtures any quantity desired may be used, ranging chiefly from two or three pounds to eight or nine pounds per acre. The honey from white clover is much prized by beekeepers.

Optional Studies.—The clovers discussed in this chapter all belong to the genus *Trifolium*. Study more about all the members so far as you can.

Red clover, T. pratense.
Mammoth clover, T. pratense perenne.
Alsike clover, T. hybridum.
Crimson clover, T. incarnatum.
White clover, T. repens.
Berseem clover, T. Alexandrianum.
Hungarian clover, T. pannonicum.
Yellow suckling clover, T. filliforme.
Carolina clover, T. Carolinianum.
Yellow hop clover, T. agrarium.

FIG. 103.—White clover is good for pastures and is often mixed with blue grass. When not pastured it becomes tall enough to cut for a light yield of hay.

Red clover was probably first cultivated by the Medes and Persians and was introduced into Spain and Italy in the fifteenth century. It moved northward into Flanders and was carried from Holland to England in 1633. Its introduction in America was probably in Pennsylvania in 1770 by German settlers.

Alsike clover is often called Swedish clover to contrast it with the red or German clover. Its name is from a Swedish village. It was brought to England in 1834 and probably came to America since that date.

Crimson clover was probably first extensively cultivated in southern France and northern Spain. It spread over Europe more recently and was brought to Pennsylvania about 1820. Little use was made of it until the end of that century.

Field Trips, Exercises, Projects, and Problems

1. **A local survey** may develop such points as the following: What clovers are grown; soil adaptations; enemies; rates of seeding; mixtures; rotations; yields; curing; handling; feeding; sales prices.

2. **Problems.**—Any arithmetical problems may be based upon the census reports on clovers. Others can be formulated by students on facts gathered from the survey.

3. **Clover Charts.**—Lists of the Trifolium clovers with uses; benefits of crimson clover; differences between mammoth and red clover; market grades of clover hay; advantages of alsike clover; merits of legumes. (Fig. 104.)

4. **Clover pictures** may be gathered from seed catalogues; machinery pictures from implement dealers; photographs from local growers and exchange clubs.

5. **Debates.**—"Red clover *vs.* alsike or other clovers," "Crimson clover *vs.* rye for green manure," "Clover *vs.* alfalfa."

6. **Field Trips.**—Visit fields where clover is being harvested or thrashed for seed. If difficulty in growth of clovers has been found, visit successful fields to study methods. Observe liming for clover. Get a peck of lime and put it on a square rod of failing clover, and watch the effects later.

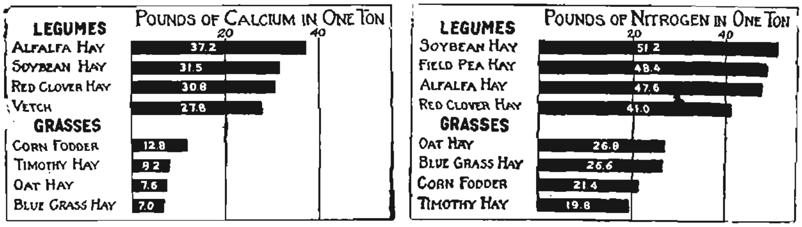


Fig. 104.—Pounds of nitrogen and of calcium in common legumes and grasses. A good subject for a chart. (Wisconsin Station.)

7. **Exercises.**—(a) Collect several samples of each kind of clover seed. (b) Compare each kind for weeds and determine percentages of purity. (c) Compare different clover seeds until each can be recognized separately. (d) Collect clover roots and compare depths and nodules. (e) Collect clover plants in bloom, drying and mounting each. (f) Grow clover seeds of different kinds as directed for alfalfa. (Chap. VIII.)

8. **Clover Projects.**—Begin crimson clover projects at seeding time. This may take place after school is opened in the fall. Continue until the crop is completed and used, either for seed, for green manure, or for hay. Red clover projects may begin with seeding and should continue until the first crop or perhaps the second growth is harvested, taking two years. In order to complete a red clover project in one year, one portion of the project may be starting the crop in one field, and the remainder of the project may be on a field which had already been started the year before.

Questions and Investigations

1. Give regions suited to red clover.
2. What are its soil requirements?
3. Describe methods of starting red clover.
4. Give clover rotations locally or otherwise.
5. Give methods of curing clover hay.
6. Compare mammoth clover with red clover.
7. Compare alsike and red clover.
8. Describe the growth and use of crimson clover.
9. Give the adaptations and uses of white clover.

ANNUAL LEGUME ENTERPRISES

Analysis into Jobs.—The following jobs include the growing of Canada field peas, sowbeans, cowpeas, vetches, peanuts, lespedesa, beans and velvet beans. They are all treated together because of their natural relationship. References are to pages in *New Agriculture*, Davis' *Farm Projects and Problems*, and to numbers of available *U. S. Farmers' Bulletins*. See *Field-Crop Enterprises* and *Southern Field-Crop Enterprises.*

1. **Deciding whether or not to grow one of these crops,** p. 169; *Farm Projects*, 166; *Bulletins*, 515, 690, 693, 1143, 1153, 1253, 1255, 1308, 1509, 1605, 1617, 1656, 1663. *Local inquiry.*—(*a*) List the special uses of markets for each of these crops grown in your region. (*b*) With what success do farmers grow each of these? (*c*) With the entire list interview farmers regarding each.
2. **Choosing the crop and variety,** pp. 169–173; *Farm Projects*, 166–168, 169; *Bulletins*, 515, 690, 693, 1143, 1148, 1253, 1255, 1276, 1509, 1520, 1605, 1656, 1663. *Local inquiry.*—(*a*) What varieties of each of these crops are used in your region? (*b*) Get the best growers to discuss varieties. (*c*) Find prices of seed and obtain yields for the best varieties.
3. **Selecting soil, field and acreage,** pp. 172–173; *Farm Projects*, 167; *Bulletins*, 690, 921, 1143, 1148, 1253, 1475. *Local inquiry.*—(*a*) What soils are chosen when the crop is to be grown for soil improvement? (*b*) What local soils are preferred when money crops are grown? (*c*) Try to formulate rotation systems used with these crops. (*d*) What sizes of fields are grown for various purposes?
4. **Securing seed; inoculating; testing,** pp. 31–33, 66, 151, 172; *Farm Projects*, 170–171; *Bulletins*, 428, 1148, 1253, 1255, 1275, 1496. *Local inquiry.*—(*a*) Interview farmers regarding sources of seed for each of these crops. (*b*) Get them to compare home-grown with purchased seed. (*c*) How is home-grown seed recleaned? (*d*) Which of these crops requires inoculation for local soils? (*e*) Get opinions of farmers regarding the value of testing these seeds.
5. **Buying and mixing fertilizers,** pp. 27, 44, 45, 69; *Farm Projects*, 171; *Bulletin*, 1148. *Local inquiry.*—(*a*) For any of these crops grown for market, what fertilizers are purchased? (*b*) Find their formulas and determine whether nitrogen as well as phosphorus and potash are included. (*c*) Get farmers' reasons for and against including nitrogen in fertilizers.
6. **Keeping records,** pp. 18, 19; *Farm Projects*, 33, 35, 77, 78; *Bulletins*, 511, 572, 782, 1182. *Local inquiry.*—For the money crops draw forms suitable for keeping cost accounts and ask local growers to keep records for use in calculating total cost and net returns.
7. **Preparing soil for planting; liming,** p. 172; *Farm Projects*, 171–172; *Bulletins*, 921, 1253. *Local inquiry.*—Make lists of these crops which require and which do not require liming in your region. (*b*) Soil preparations for these crops should be studied so as to be able to describe the best methods.
8. **Planting and fertilizing,** p. 173; *Farm Projects*, 171; *Bulletins*, 690, 1148, 1253, 1255, 1605, 1656. *Local inquiry.*—(*a*) What machinery

is used in planting and in fertilizing these different crops? (*b*) What hand methods are used? (*c*) Find the rates of seeding per acre for local soils. (*d*) List the dates of seeding for different crops and different purposes.

9. **Controlling enemies.** *Farm Projects*, 168; *Bulletins*, 660, 1275, 1537, 1605. *Local inquiry.*—(*a*) Try to make a complete list of all enemies of these crops so far as they are grown in your region. (*b*) How are stored products protected from weevils and other enemies? (*c*) What farmers choose varieties to help control diseases?
10. **Harvesting for hay or for seed,** pp. 172–174, 176; *Farm Projects*, 174–175; *Bulletins*, 1253, 1525, 1615. *Local inquiry.*—Special methods of harvesting each one of these crops should be discussed with farmers.
11. **Using, marketing and feeding,** pp. 169–176; *Farm Projects*, 174–175; *Bulletins*, 1153, 1253, 1255, 1308, 1573, 1617, 1656, 1663. *Local inquiry.*—(*a*) Review list of uses found in Job 1. (*b*) Trace the management for each of these uses to show the profits accruing to the grower. (*c*) Describe methods of marketing which you find locally.

CHAPTER X

GROWING ANNUAL LEGUMES

An annual plant is one which grows from seed, produces stems, leaves, blossoms and seeds and dies within one year.

Some are summer annuals, dying as winter comes on, such as cowpeas, soybeans, summer vetch and lespedeza. Others are winter annuals, making part of their growth in the fall and completing the life cycle the following spring, as crimson clover, winter vetch, and burr-clover.

Cowpeas are extensively grown for forage in the central and southern latitudes of America. The crop is cured for hay and the growing fields are used for pasture. The seeds of a few varieties, such as Blackeye, are also used for human food.

Cowpeas are good soil builders when turned under as green manure. The plant resembles the garden bean in leaf formation, shape of seeds, blossoms and pods. There are many varieties, differing widely in their habits of growth and the requirements for the production of hay or seed. New Era and Extra Early Blackeye may be cut for hay in eight to ten weeks after germination, or will produce a fairly good crop of green manure in less time. Whippoorwill, Wonderful, and Unknown are much more vigorous growers and require longer time. Iron is believed to be one of the most resistant varieties against rust disease.

Growing the Crop.—Seeding is done in warm weather. If the soil is cold and wet the seeds will seldom germinate.

About five or six pecks of seed are used per acre when broadcasted, and about half as much when drilled in rows. Cover to a depth of an inch or so.

For making hay the crop may be cut when about one-third of the pods have turned brown, or a little earlier. Common mowers and rakes are used in hay making.

As mentioned in the corn chapter, cowpeas are often drilled between corn rows or are planted in the rows with the corn.

Experiments have shown that the yield of corn is increased and good forage is left for livestock after corn harvest.

Cowpeas are also sown broadcast with millets and sorghums, the mixture producing heavy yields of palatable hay for cattle.

Soybeans (Fig. 105) are growing in popularity in America. They are used for the same purposes as cowpeas. The seed is

much richer in oil and the ingredients of seed and hay are otherwise fully equal to cowpeas. Oil is pressed from seeds for commercial uses. The seed is readily thrashed by machines, while the seed of cowpeas is chiefly picked by hand.

Soybean seed is of three colors: Black, yellow, and green. Each color has several varieties differing in length of time for maturing —early, medium, and late.

The crop is profitably grown in all except the northern tier of states. Hot weather is the best time for seeding. Two or three pecks to the acre may be drilled, or twice this amount is used

FIG. 105.—Soybeans cut with a binder. (Kentucky Station.)

when broadcasted. If covered more than one-half an inch the little plants may be broken near the seed leaves during germination. The crop is more commonly harvested for seed than cowpeas because of the seed ripening more uniformly and the ease of thrashing. Yields of the two crops are similar.

Soybeans with Corn.—Each year the number of farmers growing soybeans in corn is rapidly increasing. In the warmer regions soybeans are drilled in the row with the corn at planting time, but some prefer to sow the soybeans after cultivation is over. The combined crop may be used for silage or hogs may be fattened in the field, a plan called "hogging off."

Vetches are of two main types: Those which are grown as summer annuals and those grown as winter annuals. Hairy vetch is the best example of the winter vetches. (Fig. 106.) All vetches are alike in requiring a companion crop, as small grain, to climb upon. Hairy vetch is sown with fall grain as a winter cover crop,

about one peck of vetch seed being used in the mixture. The crop may be turned under in the spring as green manure, or may be cut for hay when the grain is in the blossom stage, or may be allowed

Fig. 106.—Winter vetch and rye make a good mixture for forage, for green manure, or for winter cover crop. (U. S. D. A.)

to mature seed and then be cut with a binder and thrashed. The seeds are readily separated in the fanning mill.

Summer vetch is sown in the spring with early spring grain as it will endure spring frost fairly well. The chief species of summer vetch is *sativa.* (Fig. 107.) As the seed is grown in western Oregon it is sometimes called Oregon winter vetch. In the Gulf region it is somewhat used as a winter annual, but is not so good for that purpose as hairy vetch. The seeds are a little smaller than those of winter vetch, but about the same amount is used per acre in sowing with spring grain. The growth is very rapid and the mixture may be used in the three ways mentioned for winter vetch and grain.

Canada Field Peas.—This crop is almost like the English garden peas. The seeds are slightly smaller but are often harvested for use in canneries, marketing and thrashing being similar to those operations with grain. The ripened seeds are often used as human food, particularly in soup mixtures. The vines require a companion crop to support them. In northern states the crop is commonly seeded with spring grain. One bushel of each per acre

FIG. 107.—Vetch field inoculated, on right. Strip not inoculated, on left. (Fights of the Farmer.)

is a good mixture. The combined crop is excellent for hay if cut in the blossom stage or soon after. The yields are heavy and the quality good. If the seeds be allowed to mature, peas may be separated from the grain by the use of fanning mills after thrashing.

Peanuts are grown chiefly in the southern half of the United States (Fig. 108), either alone or in rows of corn. There are several varieties. One bearing only one seed in the pod is locally called "*goober pea*." It is more used for livestock, while larger varieties such as the Virginia peanut are more commonly used for human food.

This crop prefers a light, sandy soil, but will yield well on heavier soils. Yellow or dark-colored soils discolor the product and render it less salable. Lime in the soil is an important asset. The soil should be rather well drained and light rainfall rather than extreme moisture favors growth. This crop is tender and

should never be planted until spring frosts are over, and there should be from 90 to 125 days before the fall frosts occur. Hulling seeds before planting is practised with large varieties. Others are soaked before planting.

When grown alone they are usually planted in rows thirty to thirty-six inches apart and about ten or fifteen inches between

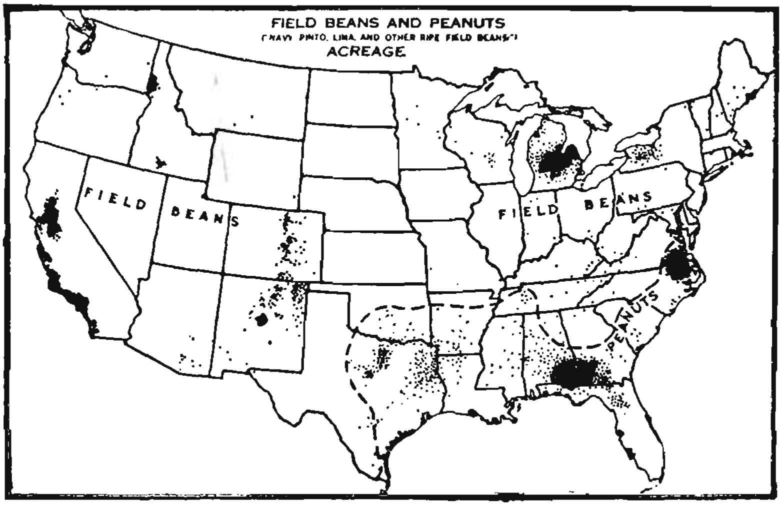


Fig. 108.—Distribution of peanuts and of field beans. The peanut crops of the Gulf states are used chiefly for peanut butter and for livestock; those of Virginia and North Carolina are more for roasting. Each dot on map 1,000 acres. (U. S. D. A.)

plants in the row. The Spanish variety is somewhat erect and may be planted closer than others.

One peck of shelled Spanish peanuts should plant an acre. Five times the bulk would be required if the shells were not removed.

Clean culture should be practised throughout the growing season, or until the vines cover the ground. The blossoms which are necessary for the production of seeds, are first formed above the ground and then the pistil stem is extended beneath the soft soil where the nuts develop. Because of this habit it is important during cultivation to throw a little loose soil toward the rows.

Harvesting.—The vines are lifted with special machines or with plows or may be pulled by hand if the soil is loose. For curing they are piled in slender shocks around rigid poles in the field. Careful curing preserves the color and better prices result. After the nuts are removed from the plants the latter are fed to livestock. Separation of nuts from the plants is usually by hand.

but machines are devised by which time and expense are saved. After this the nuts are spread in thin layers on floors as in attics to more thoroughly dry before marketing. It usually pays to clean them by revolving in barrel churns or otherwise to polish the hulls. *For varieties sold to oil factories this is not practised.*

Field beans are sometimes spoken of as white or navy beans. The leading states in their production are Michigan, New York, California and Maine. (Fig. 108.) The crop is chiefly used for human food, being sold in the dry form and as canned baked beans.

Culture.—Planting is done in late spring a week or two after corn planting time. The rows are commonly thirty to thirty-six inches apart and the plants stand close together in the rows.

Small-seeded varieties will require about one-half bushel of seed per acre. Three or four times as much is needed for larger varieties. Avoid using seeds which are affected with anthracnose disease or infested with bean weevils. Harrowing twice before the beans are up will aid greatly in letting the crop keep ahead of weeds. After the seedlings have dropped the seed leaves, cultivation between the rows should be frequent and thorough. Avoid cultivation when the vines are wet with rain or dew. Little hand-hoeing should be necessary. Cultivation when dry is to prevent the spread of anthracnose disease.

Harvesting may be either by hand or by two-row machines. The vines, in either case, are collected in small piles for partial curing. Later these are put in larger piles, sometimes around poles. When fully dry they are stored in barns. Seed pods must never be left in contact with the soil during wet weather. Thrashing may follow soon after curing. Damp pods will not thrash well. When too dry the beans split more easily. The speed of the thrasher must be governed to suit the condition of dryness. Because of these difficulties thrashers with two cylinders are commonly used, one cylinder running faster than the other.

Japan clover or lespedeza has spread somewhat naturally in recent years over the southern states from Virginia to Texas. It is now more generally sown as seed is produced for that purpose in several Southern states. It is a low, fine-stemmed summer annual with small leaves somewhat resembling alfalfa. It adapts itself well to a wide range of soils, frequently growing where other crops or even weeds will not thrive. It has found a warm place in the heart of the southern farmer who has gullied fields. It greatly improves summer pastures when mixed with grasses or sown alone. It will usually grow readily with Bermuda grass and throughout

its region will produce enough seed to readily reseed itself year after year. Because of this habit many farmers have mistaken it for a perennial plant. In rich soil the best or Korean variety may reach a height of eighteen inches if not pastured. It then makes a good yield of hay. Its range will doubtless be extended farther north if seed becomes more abundant in the market.

Velvet beans are coarse, thrifty vines grown abundantly throughout the Gulf states. The most common practice for growing the crop is to plant the seeds in every second or third row of corn at planting time. When corn is gathered, animals are turned into the fields to pasture on the stalks and velvet beans. They thrive on the great clusters of well-filled pods. When velvet beans are grown in corn the farmer seldom attempts to cut the corn for forage because of the tangled mass of vegetation produced by the beans. There are several varieties, but only two or three have come into general use. The Tennessee Station found that some varieties would, under favorable conditions, mature seeds in that state.

Fig. 109.—Three varieties of velvet beans, showing outside and inside of pods. 1, Chinese; 2, Florida; 3, Lyon. (Florida Station.)

The seed crop of velvet beans is rapidly gathered by hand, but thrashing is a more difficult task as the pods are hard and unyielding. For feed the unthrashed pods are ground into velvet bean meal and sold in all markets for livestock. As dairy feed this product is highly prized. (Fig. 109.)

Surveys, Trips, Exercises, Projects, and Problems

1. **Survey.**—A local survey regarding these legume crops should prove very interesting and valuable. Include these points: Areas for each; varieties grown; purpose of each; time of sowing; rate of seeding; harvesting; enemies; other difficulties; benefits to soil; other benefits; uses.

2. **Problems.**—Calculate the amount of nitrogen supplied per acre by one or more of these crops. Compare the benefits from growing these crops for green manure with the purchase of commercial nitrogen. Compare the protein content of these crops with the protein purchased in bran

or other mill feeds. What percentage is lost in one case or gained in the other?

3. **Charts** of annual legumes may include a list of winter annuals and the use of each; a list of summer annuals and the use of each; rates of seeding alone and in mixtures; a peanut chart may list the costs in production and in yields.

4. **Debates.**—"Peanuts *vs.* beans for profit," "Cowpeas *vs.* Soybeans," "Mixtures with grains and grasses *vs.* sowing alone," "Vetches *vs.* other annual legumes," "Lespedeza *vs.* Bermuda."

5. **Field Trips.**—Visit a peanut oil and butter factory. Visit a bean or pea cannery. Study field operations on farms of the best managers. Practise in fields as many of the operations with these legumes as possible.

6. **Projects.**—Good student projects may be planned in growing field beans, peas for canneries, peanuts, and in hay crops of other annual legumes. Begin with the fall operations and continue all steps until the following fall.

7. **Trials with Projects.**—Test the value of inoculation; of commercial fertilizers or lime; of different varieties and of different soil treatments.

8. **Exercises.**—(1) Collect seeds of all of these legumes for identification and comparison. (2) If possible, secure fresh nodule specimens for study. (Fig. 38.) (3) Collect the largest plants of each and mount them on botany sheets for permanent reference. (4) Make germination tests of large and small seeds to determine effects of different depths of planting. (5) Demonstrate that when soybeans are planted too deep they "break their necks" in sprouting.

Questions and Investigations

1. Give a list of summer annual legumes; of winter annual legumes.
2. Describe the growing of cowpeas, and give their uses.
3. Describe the growing of soybeans with corn.
4. Compare cowpeas and soybeans in a number of ways.
5. Explain the hogging off of these crops and corn.
6. Compare the different types of vetches.
7. Give the adaptations and uses of Canada field peas.
8. Describe the growing of peanuts and give a list of uses.
9. How are they harvested and cured?
10. Describe the planting, culture and harvesting of field beans.
11. Tell what you can of Japan clover, its adaptation and uses.
12. Give the regions, culture and uses of velvet beans.

Farm Mechanics.—Make many hay-drying tripods or drying posts. Make seed attachment for mower to save seed of lespedeza and crimson clover. Make hurdle fence for temporary pasture. Make lime spreader; hay rack. Repair bean harvester and others; seed stripper; thresher; rake; mower; sweep; loader; baler.

Calculations.—1. Using local prices for seed, calculate the cost of seed for sowing 5 acres each of three of the annual legumes mentioned in this chapter.

2. What is the value of the fertility found in a two-ton yield of soybean hay? (See table of feeds in Appendix.) Consider nitrogen worth 20¢ a lb., phosphoric acid and potash each 6¢ a lb.

3. In like manner find the fertility value of a crop of hairy vetch turned under as green manure. Consider the yield equal to 2 tons of cured hay.

IRISH POTATO ENTERPRISE

Analysis into Jobs.—The main teaching units in the potato enterprise are included in the jobs here listed. The references are to pages in *New Agriculture*, Montgomery's *Productive Farm Crops*, and to *U. S. Farmers' Bulletins*. See also special potato book by Stuart.

1. **Deciding whether or not to grow potatoes**, p. 177; *Farm Crops*, 255, 264; *Bulletins*, 1064, 1205. *Local inquiry.*—(*a*) Ask farmers to compare Irish potatoes with other money crops for profit. (*b*) What are the local yields and markets? (*c*) What have been the prices during the last few years?
2. **Deciding acreage, soil, and choosing field**, pp. 39, 49, 177; *Farm Crops*, 264, 267, 269; *Bulletins*, 1064, 1205. *Local inquiry.*—(*a*) What sizes of potato fields are found in your region? (*b*) What soils are considered best for this crop? (*c*) What crops usually precede Irish potatoes? (*d*) Draw a map of your farm and show which field you would use for this crop.
3. **Starting cover crop and providing organic matter**, pp. 43, 48, 49, 178; *Farm Crops*, 267; *Bulletin*, 1250. *Local inquiry.*—(*a*) What rotations are used which provide organic matter for potato crops? (*b*) Get farmers to suggest a good local cover crop to use as green manure for potatoes. (*c*) How many tons per acre of barnyard manure are used locally? When in the rotation?
4. **Buying and mixing fertilizer**, pp. 44, 45, 69, 178; *Farm Crops*, 267. *Local inquiry.*—(*a*) Ask growers to compare home mixing with commercial mixing of fertilizers. (*b*) Ask them what special forms of nitrogen, phosphorus and potash are best for this crop. (*c*) Get prices of these materials. (*d*) Calculate how many tons of fertilizer can be mixed by two men in a day.
5. **Choosing variety and securing seed potatoes**, pp. 179; *Farm Crops*, 257, 266, 271, 284, 285; *Bulletins*, 1332, 1436. *Local inquiry.*—(*a*) Farmers to compare local varieties for the different purposes. (*b*) Ask the county agent or other experts to do this also. (*c*) From what sources are seed potatoes obtained for local planting. (*d*) Find growers' ideals regarding good seed potatoes.
6. **Preparing the soil**, pp. 49, 50, 51; *Farm Crops*, 276; *Bulletins*, 805, 1190, 1205, 1250. *Local inquiry.*—(*a*) Ask growers to compare deep, mellow seed-bed with firm seed-bed for potatoes. (*b*) Describe the best local methods of preparing soil for the early crop; for the late crop. (*c*) How long before planting does the plowing take place?
7. **Treating and cutting seed potatoes**, p. 180; *Farm Crops*, 275, 281; *Bulletin*, 1436. *Local inquiry.*—(*a*) How much do the local crops show effects of scab or blackleg? (*b*) How many of the farmers treat seed potatoes before planting? What materials are used? (*c*) Describe the best arrangement you can find for the work. (*d*) Describe the best plan for cutting potatoes you can find locally.
8. **Planting and fertilizing**, pp. 181, 211; Farm Crops, 38, 267, 269, 274, 275; *Bulletin*, 1064. *Local inquiry.*—(*a*) How is planting commonly done by local growers? Describe different methods. (*b*) Is fertilizer spread at the same time or before or after? Describe methods. (*c*) Give rates of application of fertilizer.

9. **Cultivating,** pp. 50, 182, 213; *Farm Crops,* 276, 277; *Bulletins,* 1064, 1190, 1205. *Local inquiry.*—(*a*) Ask growers how often they harrow the field after potatoes are planted before they are too large to harrow. (*b*) Get their opinions regarding this practice. (*c*) What types of harrows are used? (*d*) How often are they used? (*e*) What types of cultivators are used between the rows? (*f*) Get farmers to compare ridging with level cultivation. (*g*) If potatoes are irrigated, describe methods used.

10. **Controlling insects and diseases,** 183–185; *Farm Crops,* 279–284; *Bulletins,* 940, 1367, 1436, 1475. *Local inquiry.*—(*a*) Describe the best local methods of fighting blight and potato beetles together. (*b*) Ask farmers regarding the cost of controlling potato enemies. (*c*) Compare costs of dusting and of spraying. (*d*) Make a list of the potato insects and diseases found in your region.

11. **Harvesting and grading,** pp. 184–187, 188; *Farm Crops,* 277; *Bulletins,* 1050, 1639. *Local inquiry.*—(*a*) Compare the different local methods of digging potatoes with the areas being considered. (*b*) Compare grading the potatoes in the field at picking time with grading afterwards. (*c*) Ask commercial growers into how many grades the potatoes are sorted. (*d*) See if varieties vary in this.

12. **Storing potatoes,** pp. 187, 188; *Farm Crops,* 278, 279; *Bulletin,* 847. *Local inquiry.*—(*a*) Get growers to give their arguments in favor of storing; also against storing. (*b*) Study local methods of storing and compare them. (*c*) Find what percentages of loss occur during storage. (*d*) Compare the cost of storage, the losses with the gains due to storage.

13. **Marketing the crop,** p. 187; *Bulletins,* 1050, 1144, 1205, 1332, 1578, 1639. *Local inquiry.*—(*a*) How do local potato sellers find their best markets? (*b*) When are potatoes usually sold? (*c*) What have been the best prices each year recently? (*d*) Give their arguments pro and con regarding coöperative marketing.

14. **Summarizing cost records,** pp. 18–19; *Bulletins,* 511, 572, 782, 1182. *Local inquiry.*—(*a*) Talk with farmers and calculate the cost of the chief operations such as fertilizing, plowing soil, planting, cultivating, harvesting and storing. (*b*) Compare cost of each of these operations on different farms. (*c*) Compare the total cost of production with returns from crop.

CHAPTER XI

IRISH POTATO ENTERPRISE

The Irish potato is a true underground stem with true buds called eyes. As the plant is a member of the nightshade family it is related to tomato, tobacco, ground cherry, jimson weed, wonder-berry and egg-plant.

Irish Potato Regions.—New York leads in Irish potato production among the states of the Union. Other states in order of production are Michigan, Ohio, Iowa, Illinois, California, Colorado, New Jersey, Washington, Indiana, and Nebraska. Maine far exceeds the others in yield per acre. The next four states in yield per acre are Michigan, New York, Wisconsin, Pennsylvania. From these statements it must not be inferred that other states are not suited to the growth of this crop, as it is grown in every state of the Union at greater or less profit.

Selecting Soils for Irish Potato.—The crop will thrive on a wide range of soils, but certain types of soils are better than others. Loams containing a fair proportion of sand, gravel, or shale are best. Very light or very heavy soils should be avoided. Peaty soils have been sometimes used in growing potatoes. The best soils are loose and friable and well supplied with organic matter, well drained, and have plenty of capillary moisture. Cool, moist soils furnish ideal environment for the growth of tubers.

The elevations affording good drainage are best. Rather high altitudes are better than near the sea-level because of atmospheric conditions.

Soil Fertility.—As an abundance of organic matter is needed for the best growth of potatoes, the two best forms of supplying plant food are green manure and barnyard manure. The potato grower should plan his rotation so that he may turn under a green sod such as alfalfa or clover for each potato crop. Sods of leguminous plants supply both organic matter and nitrogen.

Commercial fertilizers are, however, often necessary in the growth of potatoes. A two-hundred-bushel crop of potatoes was found by experiment to average the following amounts of fertilizers removed from each acre: Nitrogen, forty-two to forty-three pounds; phosphoric acid, seventeen to eighteen pounds; potash, fifty-six to fifty-seven pounds. These ingredients could be returned to the soil by applying (as Stuart shows) 270 pounds of nitrate of soda,

108 pounds of high-grade acid phosphate and about 110 pounds muriate of potash. These data may serve as a general guide if we remember that smaller yields remove less plant food, but the same relative amounts. If we supply most of this nitrogen by plowing under barnyard manure or legume crops, we may avoid much of the expense of purchasing nitrogen.

The chief chemical needs of any soil in which the plant food is not well balanced for the growth of potatoes is indicated by the character of growth. These characters have been indicated in the soils chapter. A heavy legume growth used as green manure should supply to each acre seventy-five to eighty pounds of nitrogen. It would also return nineteen or twenty pounds of phosphoric acid and about fifty pounds of potash. The use of green manure is, therefore, to be highly recommended.

FIG. 110.—Applying fertilizer with a 3-row distributor for potatoes. (Stuart's The Potato.)

Applying Commercial Fertilizers.—When commercial fertilizers are used the planters are equipped with fertilizer attachments by which the fertilizer is applied at planting time. A complete fertilizer of the formula 4-6-8 or 2-6-10 may be mixed at home for potato growing. Apply four to six hundred pounds of this mixture per acre. (Fig. 110.)

Preparation for Planting.—Choose fields for potatoes on which a green crop or sod has been grown to turn under. If an early spring crop is to be planted plow the land the preceding fall. In the spring as early as conditions will permit disk the soil well and harrow the surface to produce a mellow seed bed. If late or main crop potatoes are to be grown an early planting is not so essential. Spring plowing is often practised. If a green cover crop has been growing the preceding fall and winter, it would be better to plow that under in the spring early enough to allow it to become well incorporated with the soil before planting time. The seed bed for planting potatoes should be deep and mellow and not so compact as for small grains. In preparing a seed bed a level surface is left in nine-tenths of the potato fields of the country. But in a few sections where natural drainage is poor or when water might stand if the season should prove to be wet, slight ridging or bed-

ding of the rows before planting is practised. This "bedding up" of the rows is done by throwing either two or four furrows together and then harrowing or dragging down the bed slightly before planting. This plan leaves a water furrow between each two rows and prevents drowning out of the crop. As the season advances it becomes drier and the bed is gradually worked down to the level or nearly so.

Three Types of Crops.—In northern sections and to a great extent in central latitudes there are two crops of Irish potatoes grown: (1) Early potatoes grown in spring and harvested for early markets, using quick-maturing varieties; (2) late or main-crop potatoes growing through the whole season and harvested in the fall, late varieties being used. In southern latitudes two crops of potatoes are grown: (1) Early potatoes for early market, grown in late winter and early spring or, in Florida, planted the preceding fall to hasten production for early markets, early varieties being used; (2) second or fall-crop potatoes, grown on the same or other fields during the last half of summer and fall, varieties of medium or early maturity being used.

Varieties to Grow.—In choosing varieties one *should decide* on which of the four preceding crops he wishes to produce. *Early maturing varieties are:* Irish Cobbler, Triumph, Early Ohio, Spaulding No. 4. Medium or late commercial varieties are: Burbank, Russet Burbank, Rural, Russet Rural, Green Mountain, Pearl, McCormick, Perfect Peachblow (Red McClure), *Brown* Beauty, American Giant, Chas. Downing (Idaho Rural).

By inquiry from growers, from county agents and from your state experiment stations, decide what varieties would best suit your soils and purposes.

Secure Good Seed.—Too often the culls from a preceding crop are used for seed. On the other hand, we should select potatoes that are true to the variety type; that are sound and healthy, uniform in size and shape; that evidently have good sprouts and eyes. Growers sometimes choose seed from heavy producing hills for the purpose of breeding up or increasing yields. (Fig. 111.) Seed potatoes are produced by officially inspected growers, who are given certificates indicating the quality of seed produced. Large growers should plan to secure seed from such sources if they do not produce any themselves. For the early spring crop seed from the preceding crop is used. For the main season crop seed is selected from late varieties of the preceding year. For the fall or second crop of the South, some growers attempt to get a stand

of potatoes by planting seed from the spring crop. To do this they weather the seed potatoes in a light place for a few weeks to induce sprouting. Even with such precautions results are usually unsatisfactory. Most growers, therefore, obtain seed for this second crop by buying northern-grown seed, which has been held in cold storage until a few weeks before planting time.

Treating Seed Potatoes.—Because of the prevalence of rhizoctonia, common scab and similar diseases, seed potatoes should

Fig. 111.—The hills that yield the most marketable tubers are best to save for seed. (U. S. D. A.)

invariably be treated to kill the spores on the tubers. Soaking seed in formaldehyde solution, one pound to thirty-two gallons, for a period of two hours, is sufficient to kill most of these spores. Where rhizoctonia or black-leg disease has been very serious, corrosive sublimate treatment is preferred. Use one common tablet to a pint of water and soak for thirty minutes. The heated treatment (p. 92) is also good for this. (Figs. 112 and 113.)

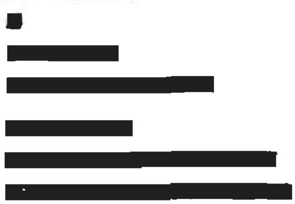
Cutting Potatoes.—In cutting seed potatoes the object is to give each eye or group of eyes a share of the storage matter to assist in germination and early growing. Experiments have been conducted to show the sizes for cutting to give best results. It is needless to say that when seed potatoes are very expensive much can be saved at planting time by cutting the pieces small.

Whether this would prove economical at harvest time would depend largely on the market price at that time. It is usually not advisable to cut the pieces to weigh less than two or three ounces

and larger than this will greatly increase the yields. A piece the size of a hen egg weighs two ounces. Simple cutters are devised

Fig. 112.—Results of a Wisconsin Station trial of disinfecting seed potatoes; clean lots above scabbed lots below.

Irsh Cobbler, Early Ohio, Triumph, and Early Rose (early varieties)		
Treatment		Per cent scab
Clean seed.	Corrosive sublimate	2.5
	Formaldehyde	23.5
	Untreated	45.5
Scabbed seed..	Corrosive sublimate	28.5
	Formaldehyde	56.5
	Untreated	61.0



for cutting each tuber at one stroke, but a far more common method is to use a single knife blade and cut the potatoes on a board.

Planting Potatoes.—If hand methods of planting are used the rows are usually marked out with a plow and the potatoes dropped at suitable distances in each furrow. Distances between rows are usually three feet or a little more. Two-eye pieces are dropped at intervals varying from one to two feet. Such planting would require from nine to fifteen bushels of seed per acre. The depth of covering light soils is about four or five inches. In heavy soils the depth is less.

Fig. 113.—Potato planter requiring two men—one to drive and one to distribute the potatoes in the dropping disk to insure uniform planting. (Bateman Mfg. Co.)

Large growers use machines for planting. (Fig. 113.) These are of two main types: (1) Those requiring two persons, one to drive the team and another to equalize the distribution of seed in a revolving disk which drops the pieces; (2) those which require only one man, the dropping being done by forks attached to the rim of a revolving vertical disk. The two-man machine is more accurate and gives a more even set in the field,

but the time of an extra man is involved. Machine planters open their own furrows, drop the seed, spread the fertilizer, and cover over the row in one operation.

Cultivating the Crop.—Many growers leave the rows covered to a depth of only about three inches and as the young plants begin to show, more soil is worked over the rows, the object being to leave the surface nearly level by harrowing once or twice. An extra harrowing can be given later with much profit. (Fig. 114.) It

FIG. 114.—A weeder may be used on fields of Irish potatoes before the crop is up and a few times after germination. Weeds are kept in check, moisture is conserved and the surface is kept loose. The work is light and rapid. (Bateman Mfg. Co.)

saves at least one other cultivation and is more rapid and effective. The first cultivation between the rows should be very deep and should stir the soil thoroughly. (Fig. 115.) This will tend to prevent packing of the soil about the roots and crusting of the surface. Cultivate again after each heavy rain and often enough to keep a good mulch and prevent growth of weeds. The roots of potatoes are not so shallow as are those of corn and sorghum. Deeper cultivation is allowable and beneficial. The cultivator should be run more shallow as the season advances. The last cultivation is usually given about the time of early blossoming of the crop. With many varieties the vines will then cover the surface fairly well.

Ridging or hilling up the rows during the cultivation period or at the last of it is sometimes done for two reasons, to prevent the

tubers from being sunburned, and to cover grasses and weeds in the row. In the most intensive commercial growing regions a slight ridging of the rows at last cultivation is commonly practised.

Irrigation.—Yields of potatoes are greatly increased by applying water at times when the soil conditions tend to check the growth

FIG. 115.—First cultivation between rows of Irish potatoes, using level culture system with an eight-shovel cultivator. (Bateman Mfg. Co.)

of the crop. The largest yields of potatoes are produced where irrigation is practised. Flooding or furrow methods of spreading the water are used, the latter being more popular. One or two applications of water will make great difference in yields even in humid climates.

Potato Insects.—*Colorado potato beetles are familiar to all who have* grown the crop. A few adult beetles live over winter and lay the crop of eggs to start the spring broods. The adults do very little eating. The eggs are orange in color and laid in masses on the under side of leaves. In gardens the adults are picked off by hand and killed and the eggs in masses are gathered before hatching. On large fields and in gardens after the eggs have hatched the young larvæ are so destructive that poisoning the surface of the plants is by far the best remedy. Several sprayings or dustings of poison are necessary to cover the new growth of the plants

Dusting poison on the plants is far more economical of labor than spraying for small areas. This also saves spraying outfits. Paris green or arsenate of lead powder may be mixed with twenty to thirty times its bulk of air-slacked lime or sifted ashes. This mixture should be applied when the plants are wet with dew, or just after a shower. The dust may be put in a loose burlap bag and, while held over the plants, is beaten with a paddle or otherwise shaken. For large areas spraying with one of these poisons is recommended. Use one pound of Paris green and one pound of fresh lime to fifty gallons of water. Use one and a half pounds arsenate of lead powder or three pounds of the paste form to fifty gallons of water. The latter is more effective for leaf-eating insects because it clings to the leaves longer.

Blister-beetles and leaf-beetles both eat the leaves of potatoes and its relatives. When their damage is noticeable spray or dust the plants as for the Colorado potato beetle.

The common stalk-borer and the potato-borer both injure this crop in some of the potato-growing districts. The grower should observe closely and take off infested parts and burn them as soon as attacks are noticed. Effectually destroy their hibernating places by plowing under the vines in the fall and thoroughly cleaning up all rubbish, or by raking and burning. The latter method is recommended if attacks are very severe. Plant lice are very serious in some localities, and should be sprayed with a solution of nicotine sulfate. (Fig. 116.)

FIG. 116.—Pink and green plant lice on Irish potato plant, best treated with nicotine sulfate. (*Maine Station.*)

Diseases of Potatoes.—Methods of preventing scab and rhizoctonia have already been given. (Fig. 117.) Early and late blights are more or less severe in all potato-growing sections. Early blight attacks the foliage and the losses are sometimes very severe. Late blight may be severe where the main crop or the fall crop is grown. This disease first attacks the foliage and then the stems and then the tubers. The effect upon the tubers is severe rotting while in the field or in storage. The chief remedy against both of these diseases is thorough spraying with Bordeaux mixture. (Fig. 118.) This mixture can be combined with the poison sprays while fighting insects. A number of applications are necessary to completely control the disease. The work can hardly be too thorough and too frequent. All new growth must be protected.

The spraying must be done before rather than after infection takes place. Wonderfully beneficial results are found from spraying with Bordeaux mixture. The plants thrive so much better and the yields are so greatly increased that the cost of spraying is more than balanced by the returns.

Harvesting the Crop.—The early crops of potatoes, which are grown for early use or for early market, are often harvested before

the tubers are mature. Market prices are better early in the season. As the crops flood the market prices naturally fall.

Late potatoes and main-crop potatoes can and should be allowed to mature in the soil before harvesting. This may be until the vines are killed by frost or until they have died from ripening or from blight.

Digging potatoes by hand may be either with tined hoes or spading forks. This method is followed for small fields and gardens

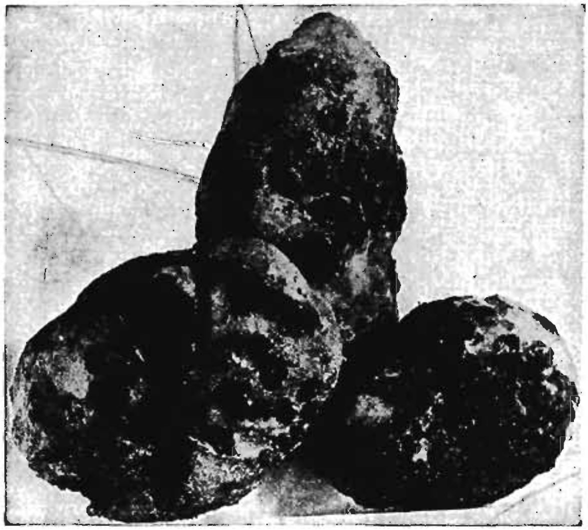


FIG. 117.—Potato scab disease should be kept out of the soil by planting only such seed potatoes as have been treated with formalin or corrosive sublimate. (U. S. D. A.)

and for large areas where labor is cheap. In this method the potatoes are usually picked up as dug and a clean harvest is the result. Much injury to the tubers is likely to result from this method of digging potatoes. If the workman is careful such damage may be very slight.

Horse diggers are of several types: (1) Elevator potato diggers (Fig. 119) by which the potatoes are lifted by a broad, strong shovel point with a mass of soil and carried over the frame by rods and tins and left behind the machine. During the passage of the mass over this grating most of the soil is removed and the potatoes are left in a row on top. (2) Ordinary one- or two-horse plows, which turn the soil and potatoes up and to one side of the row. (3) Plows with rigid tines or fingers at the back part of the moldboards help to separate the tubers from the soil. These tines may

be on both sides of the plow. (4) A similar digger in which the tines are agitated by a sprocket wheel to secure better separation of tubers from the soil.

The elevator diggers are usually drawn by three or four horses, the others by one or two horses.

Picking and Grading.—More care than is usually practised

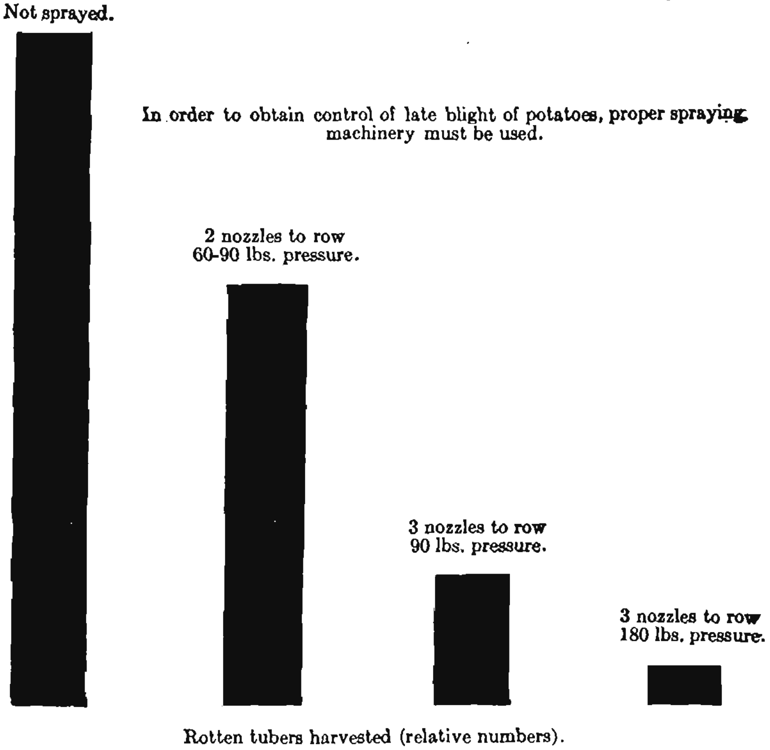


FIG. 118.—In order to obtain control of late blight of potatoes, proper spraying is necessary. Rotten tubers harvested after different treatments at the New Hampshire station were in the relative numbers shown by the bars.

should be exercised in handling the tubers. So many kinds of infection may enter tubers which have been injured that great losses often result. When the weather is hot potatoes should be gathered from the field as promptly after digging as possible. If the digging is done in late afternoon cooling in the field over night will aid in the successful handling of the tubers.

In various sections of the country different practices of handling the crop are used. In many commercial fields the potatoes

are gathered into splint baskets, crates or boxes. These are sometimes emptied into sacks or barrels in the field or may be hauled to grading places direct. If baskets are used for marketing the same baskets are often used in the field for gathering.

Grading potatoes is coming to receive more attention than formerly. The Bureau of Markets established and defined standard grades: U. S. Grade Fancy, U. S. Grade No. 1, and U. S. Grade No. 2. In markets or in some potato-growing regions simple machines are used for mechanically sorting potatoes into sizes. While the potatoes are passing through these graders the operator sorts out injured, diseased or otherwise objectionable tubers.

FIG. 119.—A modern potato digger separates the potatoes from the soil and leaves them on the surface. (Bateman Mfg. Co.)

Marketing Potatoes.—The early crops are usually marketed directly from the fields, as a loss of a single day may result in a lower price. Large growers or coöperative associations of growers plan to have cars on the nearest tracks ready to receive the crop as it is harvested. These cars are sent to the best markets as rapidly as loaded. By telephone and telegraphic communication with many markets, growers are able to ship to points where the demand is greatest. Glutted markets are thus usually avoided. Coöperative associations can handle such matters better than individuals because of the knowledge and expense involved.

Packing in cars has recently been a matter of much careful study. Each kind of container, as barrels or baskets, should be packed so as to result in the least possible damage to the product.

Storage of Potatoes.—As much of the late or fall crop will bring a better price if held until the glut of harvest time is over, some method of storing potatoes is planned by large growers. (Fig. 120.) Usually storage houses are constructed by individuals rather than by associations. Potatoes should be kept at a temperature a little above freezing. Thirty-six to forty degrees F. will usually be satisfactory for storage. Places should be rather well

ventilated but not too dry. The tubers stored should be sound and free from injury at storage time. If roughly handled great loss from rots may follow. Considerable shrinkage due to evaporation and some decay will always be found.

Pitting potatoes is a crude and common method, involving little or no expense for equipment. Inexpensive cellars, wholly or partially underground, are cheap forms of buildings for storage. Such cellars or dug-outs may be in banks or hillsides for convenience in handling the product. Expensive structures in the form of good

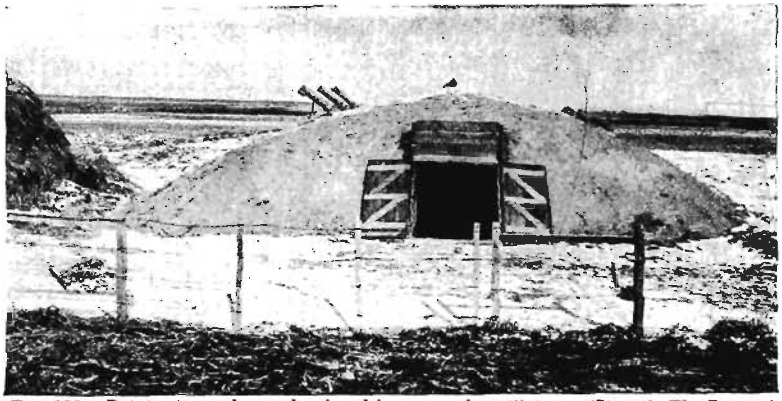


FIG. 120.—Potato storage house showing driveway and ventilators. (Stuart's The Potato.)

storage houses are found in Maine and in some other states. Houses with concrete walls are sometimes built in the Greeley section of Colorado. It is important that walls be so constructed as to prevent injury from frost.

Optional Studies.—*Historical.*—The common Irish potato was found by early explorers in Peru and Chile. As early as 1542 the crop was cultivated there and samples were sent to Europe. Because of the extensive growth of the crop in Ireland a little later, the name has clung to it since its introduction into North America.

Potato Breeding.—The potato plant blossoms readily, some varieties blossom profusely, but seldom are true seeds formed. New varieties have been produced by potato breeders by crossing one form with another by hand pollination. Few new varieties have been produced naturally by true seeds. The term seed, as used commercially in connection with potato crops, refers to tubers used for planting. When such tubers are selected from heavy-yielding plants the tendency is to produce larger crops. Hill selection is one of the most practical methods of crop improvement.

Surveys, Trips, Exercises, Projects, and Problems

1. **Potato Survey.**—Make surveys of farms where potatoes are grown to determine local practices: Varieties grown; time of planting and harvesting; rotation of crops for potatoes; use of green manure; use of barnyard manure; use of commercial fertilizers; ridge or level methods

for planting; how crop is planted; source of seed; treatment of seed; size of cutting; fighting enemies; ridge or level cultivation; methods of harvesting; grading and marketing.

2. **Problems from the Survey.**—*After tabulating the results of the survey students should make many comparisons of minimum and maximum and average profits; compare spraying with no spraying; compare results where grading or no grading are found; calculate the number of bushels of seed per acre under different methods of cutting and planting.*

3. **Potato charts** should be made on such subjects as the following: Table showing rates of seed per acre; items in cost of growing potatoes; rates of planting and yields.

4. **Pictures for placards** should be collected and mounted. Get catalogues from implement dealers to show type of planters, diggers, etc. Collect catalogues from seedsmen and take pictures of standard varieties of potatoes.

5. **Discussions and debates** may be conducted on such topics as the following: "Ridging *vs.* level methods of preparing seed bed," "Ridging *vs.* level methods of cultivation," "Alfalfa or other legumes *vs.* commercial fertilizers," "Coöperative *vs.* individual marketing."

6. **Field Trips.**—Take trips at different times to study methods of growing and managing the crop. You can see and understand better than if you are merely told the variations in methods by different growers. Always plan definitely the purposes of each trip in advance, but many additional points may be observed incidentally.

7. **Potato-growing projects** should be planned by students indicating in sequence all the steps involved in the preparation for the crop as well as the production of the crop and marketing. Make one column show all of these steps. Opposite each step show the studies involved and references for such studies. From one to five acres of Irish potatoes is a good size for a student project.

8. **Demonstrations with Projects.**—Plan to make comparisons of different methods while conducting the potato project. One part may be barnyard manure, another part green manure and a third part commercial fertilizer. Fall plowing may be compared with spring plowing. Ridging as the crop is laid by may be compared with level culture.

9. **Laboratory Exercises.**—Collect good representative tubers of each available variety. These may be placed on plates and characteristics of each variety thoroughly studied. With a potato score card let a number of samples of one variety be scored. The score card used by the growers near Greeley, Colorado, is as follows:

Size	20
Too large, cut 2	
Too small, cut 12	
Not even, cut 6	
Appearance	60
Not bright, cut 10	
Dirty, cut 10	
Scabby or wormy, cut 40	
Shape	10
Quality	10
Unsound, cut 5	
Brittle or spongy, cut 5	
Total	100

Make cooking tests of two or more varieties.

Study potato starch grains under the microscope. Make cross-sections of tubers to study different parts of the tuber. Collect and study diseased tubers and insects that attack the potato.

Questions and Investigations

1. How does your state rank in the production of Irish potatoes?
2. Describe good Irish potato soils.
3. How much fertilizer is needed to replace the plant food used by a two-hundred-bushel crop?
4. Describe the preparation of potato soil for planting.
5. What types of potato crops are grown in your section?
6. What varieties are used for each type?
7. Describe these varieties.
8. How is seed secured for local planting?
9. Describe the treatment of seed potatoes for scab.
10. What different plans are used locally for cutting potatoes?
11. Describe hand planting and machine planting.
12. Give directions for good cultivation.
13. What potato insects and diseases are serious locally? Give remedies.
14. Describe two good methods of harvesting potatoes.
15. Give directions for grading.
16. How are potatoes marketed locally? Give other ways.
17. Describe methods of storing potatoes locally and elsewhere.

Farm Mechanics.—Make crates; crane, tank, and platform for treating seed potatoes; grading rack; storage bins; storage cellar. Repair grading machine; planter; digger; sprayer; cultivator.

Calculations.—1. A field which was sprayed three times produced 82 bbl. of potatoes per acre, while an adjoining field, not sprayed, produced 45 bbl. per acre. If the cost of the three sprayings was $2.50 per acre, what was the net loss per acre due to not spraying? Use current prices of potatoes.

2. In a trial to determine the value of heavy seeding, the rates of seeding were 12 bu. and 18 bu. per acre. The corresponding yields were 110 bu. and 160 bu. respectively. Seed cost $1.50 and the crops sold for 90¢ per bu. Find the increased value of yield due to heavy seeding after deducting cost of extra seed.

3. Calculate the cost of material to treat seed potatoes for 10 acres using 15 bu. per acre, if each bushel used up a gallon of material. (See p. 180.) Consider formaldehyde as costing 40¢ per lb.

4. If potato rows are 3 ft. apart and the seed pieces are planted 18 in. apart, how many pieces are needed to plant an acre (43,560 sq. ft.)?

5. What will be the weight of this amount of seed if the pieces average 1 oz. each? How many bu. per acre?

6. A crop of potatoes yielding 200 bu. per acre removes from the soil 42 lb. of nitrogen, 14 lb. of phosphoric acid, and 63 lb. of potash. Find the cost of supplying this fertilizer if nitrogen costs 20¢ and the other materials cost 6¢ each per lb.

7. How much nitrate of soda having 15% nitrogen is needed to supply the 42 lb. per acre?

8. How much superphosphate having 16% phosphoric acid is needed to supply the 14 lb. per acre?

9. How much muriate of potash having 50% potash is needed to supply the 63 lb. per acre?

SWEET POTATO ENTERPRISE

Analysis into Jobs.—The following teaching units or jobs are the main operations in the pursuit of sweet potato enterprises. References are to pages in *New Agriculture*, Davis' *Farm Projects and Problems*, and to numbers of available *U. S. Farmers' Bulletins*. See also *The Sweet Potato* by Hand and Cockerham.

1. **Deciding whether or not to grow sweet potatoes**, p. 191; *Farm Projects*, 223; *Bulletin*, 999. *Local inquiry.*—Get advice of farmers regarding this, with their reasons.
2. **Deciding soil, acreage and choosing field**, pp. 191, 192; *Farm Projects*, 223, 224; *Bulletin*, 999. *Local inquiry.*—Find sizes of fields, local rotations, and most suitable local soils.
3. **Starting a cover crop and providing organic matter**, pp. 192, 193; *Farm Projects*, 28, 48, 49; *Bulletins*, 999, 1250. *Local inquiry.*—The opinions of growers regarding too much or too little organic matter should help you.
4. **Buying and mixing fertilizers**, p. 191; *Farm Projects*, 225; *Bulletin*, 999. *Local inquiry.*—Study methods of buying fertilizer and try to organize a circle for buying together.
5. **Choosng the variety**, pp. 191, 192; *Farm Projects*, 224; *Bulletin*, 999. *Local inquiry.*—Opinions regarding local varieties should be considered.
6. **Securing seed; treating**, *Farm Projects*, 224–225; *Bulletins*, 999, 1059. *Local inquiry.*—How do farmers get seed and plants free from disease?
7. **Preparing and starting hotbed**, pp. 192, 193; *Farm Projects*, 225–226; *Bulletin*, 999. *Local inquiry.*—Study plant beds and describe the most economical.
8. **Preparing the field for planting**, p. 193; *Farm Projects*, 226; *Bulletin*, 999. *Local inquiry.*—(*a*) What fraction of the farmers prepare soil by bare-fallow methods? (*b*) Do they prefer a loose, deep seed bed or firm soil?
9. **Planting and fertilizing**, pp. 193, 194; *Farm Projects*, 226–228; *Bulletin*, 999. *Local inquiry.*—(*a*) Study different methods of transplanting plants so as to choose the best. (*b*) What fertilizing is done at planting time and what afterward?
10. **Cultivating**, p. 194; *Farm Projects*, 228; *Bulletin*, 999. *Local inquiry.*—(*a*) How many growers use ridge planting and culture? (b) How many use level methods?
11. **Controlling enemies**, pp. 194, 195; *Farm Projects*, 228–229; *Bulletins*, 999, 1059, 1537. *Local inquiry.*—What enemies are worst in your region? How controlled?
12. **Harvesting and grading**, p. 195; *Farm Projects*, 229–230; *Bulletins*, 999, 1442. *Local inquiry.*—Describe local methods of harvesting and grading.

13. **Storing and curing**, pp. 195, 196; *Farm Projects*, 230–231; *Bulletins*, 1267, 1442. *Local inquiry.*—Visit or have described local storehouses and curing methods.

14. **Marketing.** *Farm Projects*, 231; *Bulletin*, 1144. *Local inquiry.*—(*a*) Study local marketing methods. (*b*) Ask farmers if they would join a marketing pool.

15. **Summarizing cost records**, pp. 18, 19; *Farm Projects*, 33–35, 77, 78; *Bulletins*, 511, 572, 782, 1182. *Local inquiry.*—Draw suitable forms for cost items and sale items.

CHAPTER XII

SWEET POTATO ENTERPRISE

THIS crop is increasing in importance in America. About three-fourths of a million acres of sweet potatoes are annually grown in the United States.

Regions for Sweet Potatoes.—For the best production of this crop 105 days or more of time is required between spring and fall frosts. This is a very tender crop, easily affected by frost. Warm days and nights are best for its growth. The South Atlantic and Gulf states constitute the chief sweet potato belt, but the crop is grown as far north as northern Nebraska, the Ohio River and southern New York. Important sweet potato regions are located in New Jersey, Virginia, and Maryland, particularly near the Atlantic seaboard. In Mercer County, California, large quantities of sweet potatoes are produced by irrigation.

Sweet potato soils are chiefly of a sandy nature, either medium sandy loams or light sandy loams. The crop does not thrive well on heavy soils. The light soils, to hold moisture well, should be underlaid with clays or heavy loams. The roots thrive best in light soils over-lying heavy subsoils.

Soil Fertility.—Enough plant food should be present in the soil to produce a fairly good growth of vines, but the soil should be poor enough to not induce a heavy vine growth. A good crop is seldom produced if the vine growth is extremely heavy. Poor soils are, therefore, remarkably well suited to this crop. When fertilizers are necessary they should supply the soil with little nitrogen. Potash and phosphate would be preferred. Light applications of these to stimulate growth are better than large amounts. When green manure and stable manure are used, they should be applied early enough in the rotation to be well rotted and somewhat exhausted before sweet potatoes are grown on the field. Enough organic matter can be thus supplied to cause the soil to retain moisture well for the growth of crops.

Varieties of Sweet Potatoes.—We commonly find sweet potatoes of three colors, yellow, white, and red, and market preferences should be determined in deciding what color to grow. There are two main types, differing in texture, those producing a dry, mealy product when cooked, as Jersey Yellow, and those producing a syrupy or rich, moist flesh when cooked, as Hayman and the

"yams." The latter are chiefly preferred in southern markets and the former are sometimes prefererd in northern markets. Nancy Hall and Nancyman are popular varieties east of the Mississippi. (Fig. 121.)

Starting the Plants.—Young plants used for setting in the fields are almost always produced by growing them from sweet

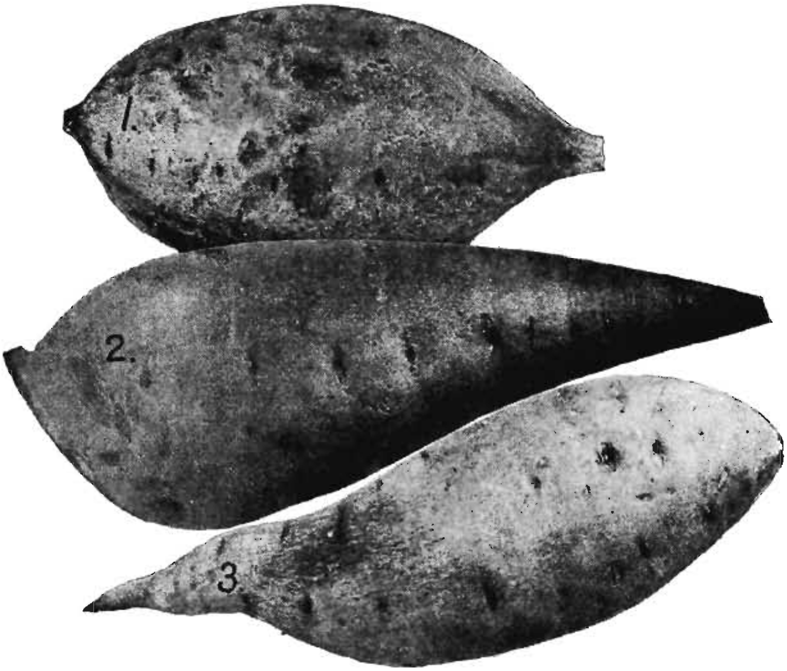


FIG. 121.—Good varieties of sweet potatoes. 1, *Triumph, a good shipper for northern markets*, drier than Porto Rico or Nancy Hall. 2, Porto Rico, popular in South for rich flavor and color, and soft juicy flesh. 3, Big Stem Jersey, dry and mealy, handles well, suits northern markets. (*Florida Station.*)

potatoes free of disease in hotbeds or coldframes. (Fig. 122.) In the northern limits for this crop hotbeds are used. To heat such beds, flues, heated by fires, are often run lengthwise under the beds; but in many other instances hotbeds, heated by fermenting manure, are used. A glass over the beds will trap much heat from the sun and aid in the growth. In the more southern latitudes for this crop coldframes well covered with glass or with cloth are used for the beds. A period of about six weeks is desirable for starting the young plants, called slips. The beds should be started this long before it is time to set the fields. A layer of two or three

inches of sand is placed in the bed, then a layer of good, healthy, treated seed potatoes is evenly spread by hand over the sand. This is covered with two or three inches of light soil or sand and the bed is kept well watered. On warm days ventilation is accomplished by raising the cover of glass.

Preparation of Soil.—The soil for this as for other root crops should be plowed very deep. It should be disked and harrowed

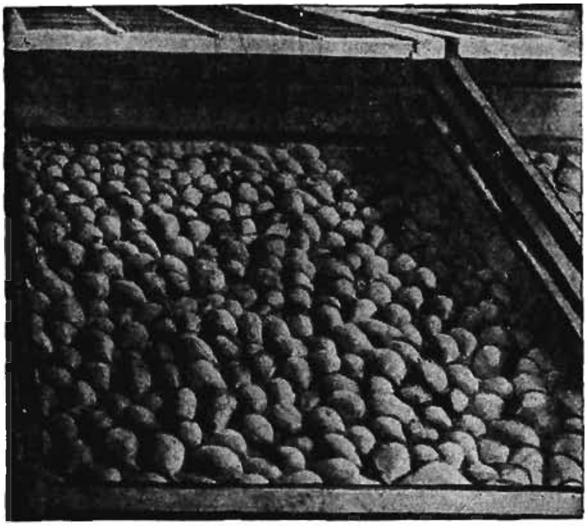


FIG. 122.—Sweet potatoes in bed ready to be covered with soil for the growth of plants. (New Jersey Station.)

as if making a good seed bed. In much of the southern territory the rows are prepared for planting by slightly "bedding up" or ridging. (Fig. 123.) This work is done with a turning plow, which throws the soil toward the ridges and leaves a drainage furrow between the rows. The crowns of the ridges are worked down a little and rows are marked off at distances of three and a half to four feet.

Transplanting.—When the slips are six or eight inches in height the strongest ones are pulled from the propagation bed by hand. The roots are usually puddled by dipping them in a thin mud of clay. They are kept moist in boxes or baskets and taken to the fields for setting. This is done a few weeks after all danger of frost is past. If hand methods of setting are used the open rows are usually made with a plow. A boy may drop the plants at intervals of eighteen inches or two feet and another person pushes

them in with a stick, pressing dirt to plants, or does the planting by hand. Machine planters are used where large areas of sweet potatoes are grown. Two boys ride at the back and place the plants, and a man drives the team. This machine opens the furrow, supplies water to each plant, and covers the roots in one operation.

A bushel of bedded potatoes will supply about two thousand good plants of the first quality. A little later other plants will be

FIG. 123.—The row is often bedded up a little, by using such a ridging machine, before setting sweet potato plants. (New Jersey Station.)

strong and can be pulled and used, if needed, for completing the field or replanting where needed.

In southern regions where the season of growth is very long, slips or cuttings are taken from the vines in the field after growth begins. These root readily when planted in moist soil, under favorable conditions. Neighbors often supply each other with such cuttings or later fields are planted from the first fields. Immunity from disease may be thus secured by exercising care in selecting cuttings from healthy plants free from the stem-rot disease.

Field Culture.—As light soils are suited to sweet potatoes, cultivation need not be deep. Shallow cultivation at frequent intervals is the general rule. This should be continued until the vines cover the soil fairly well. Vines may be turned if another cultivation is needed. If the fields are weedy, some hand work may be used in pulling or hoeing.

Black-rot is the worst disease of the sweet potato plant. The shrivelled condition of the terminal buds of the plants gives the first warning of this disease. Brown rings under the skin of cut roots should help us

to avoid them for seed purposes. Brown patches form on the potatoes in the fall. These become darker at the center. When potatoes affected by the disease are placed in storage the rot will proceed rapidly and destroy the whole lot. Rotation of crops is believed to be a help in controlling this disease. Treat seed with corrosive sublimate, one pound in 100 gallons water for 10 minutes. Secure certified seed from disease-free fields, or get certified plants grown in clean beds from such seed.

Stem-rot attacks the plants in the field near the surface of the ground. Large numbers of plants are often killed as the disease spreads. Rotting of potatoes, even in the fields, often follows as a result of this disease. Fields infested with stem-rot should not be used for growth of sweet potato plants for several years. As many plants in the field seem to resist the disease, strains of sweet potatoes immune to the disease are being established.

Insect enemies of the sweet potato are not usually serious. The tortoise-beetles or gold-bugs are probably most common. The larvæ eat the leaves and may be destroyed by spraying or dusting with arsenate of lead and Paris green as for potato beetles. Another enemy is a flea-beetle which, though less common, is harder to kill. Dipping the plants in arsenate of lead solution just before setting is recommended.

Harvesting Sweet Potatoes.—*Growers strive to harvest the* crop before frost. If any mistake is made and the vines are frost-bitten they should be cut away immediately to prevent circulation of sap into the roots. In much of the sweet potato belt the crop is harvested as soon as the potatoes are large enough to produce fair yields. Better prices are secured before the main crop of mature sweet potatoes reaches the market.

As sweet potatoes should be handled carefully they are usually dug by hand methods. Tined hoes and spading forks are used. Large fields, however, are plowed out with plows having potato digger attachments. On the beams may be rolling coulters or rakes to cut or remove the vines. Or fields may be gone over before digging, with ordinary hay rakes which will remove the vines. Elevator diggers are rather too severe and damage the potatoes.

Grading can be done at picking time or in sheds and store houses later. Shipment is often made in bushel baskets or hampers or ventilated splint barrels covered with burlap.

Storage of Sweet Potatoes.—As prices drop badly when the main crop is harvested, growers and dealers find it more profitable to provide storage houses by which much of the crop may be held for marketing after prices have recovered. To be successfully held sweet potatoes must be cured well after harvest. Some natural or artificial drying is essential to success. (Fig. 124.) If thus properly cured, and kept at a temperature a little warmer than the surrounding atmosphere, so that moisture will not condense upon the potatoes, the crop will keep well. Of course, the storage houses must be well ventilated, the walls fairly well insulated and no

freezing must be allowed. Figure 125 shows a method of storage in small piles, practised in the extreme South.

Surveys, Trips, Exercises, Projects, and Problems

1. **A Sweet Potato Survey.**—A local survey on sweet potato growing will aid greatly in understanding local conditions and farmers' problems

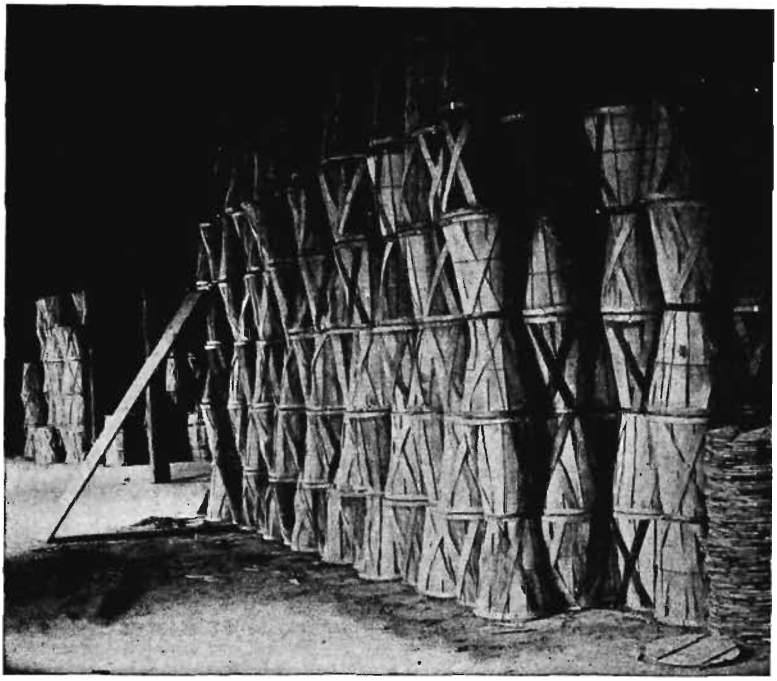


FIG. 124.—Interior of sweet potato storage house. At harvest time the hampers are packed in the field and placed in storage. They are repacked within 24 hours of shipping time. (New Jersey Station.)

with this crop. Each student may collect the data from his own farm or from his neighbor's. Make a series of questions to include the following: Varieties grown; for early or for late marketing; types of soils used; sweet potato rotations; preparation of soil, where fertilizers are used in rotation; ridge or level preparation for planting; how seed is selected; how black-rot and stem-rot are avoided; treatment of seed potatoes; heat for seed beds; size of seed beds; length of time for growing slips; methods of field setting; implements for cultivation; number of cultivations; hand work in fields; time of digging; methods of digging; how and when graded; methods of storing; kind and amount of artificial heat; losses and shrinkage in storage.

2. **Problems from the Survey.**—Calculate the production of sweet potatoes in your county or neighborhood. Calculate losses from diseases. Determine average maximum and minimum in the numbers of bushels of seed per acre. Determine the ratio existing between the sizes of beds and

sizes of fields. Compare yields from poor seed selections with those from good seed selection. Calculate losses from poor methods. Calculate the profits due to storage.

3. **Charts.**—Make a chart of the range in market prices of sweet potatoes for each month of the past year. Show on this also a graph of the fall prices for the past ten years, and another graph may show the winter prices about Christmas time. Another chart may be made showing items of cost in growing the sweet potato crop. Yields and profits may be included in this chart or on another one. A chart may be made showing the methods of constructing a potato storage house.

4. **Pictures for placards** may be gathered from bulletins, agricultural journals and seed catalogues. Photographs should be taken of different

Fig. 125.—Sweet potatoes piled for the round bank. Fifteen bushel or less in a pile allows ventilation. The potatoes are covered with straw and dirt. (Florida Station.)

varieties, of exhibits at fairs, of storage houses, of diseases, soil preparation and of harvesting and of grading.

5. **Topics for Debate.**—Joint discussions and debates may be on such topics as the following: "Does it pay to construct and use storehouses for sweet potatoes?" "Is sweet potato growing more profitable than the growing of other money crops?" "Resolved that the losses from black-rot and stem-rot can be sufficiently controlled by seed selection, treatment of seed, selecting slips, planting cuttings, and rotation of crops." "Level planting *vs.* ridge planting."

6. **Field trips** should be taken to study methods of seed selection, treating seed, making beds, transplanting, harvesting, grading, storing and marketing.

7. **Sweet potato projects,** usually ranging in size from one to five acres, should be planned by students. The scope of each should extend from the planting of cover crops in the fall to marketing of the crop produced the next year. List the steps in the project in order of natural occurrence. Let the studies involved and the references for each of these be placed opposite each step.

8. **Trials and Projects.**—Plan some valuable demonstrations of trials to accompany each project. Compare the growth of sweet potatoes following corn with sweet potatoes following clover; compare one variety with another; compare one fertilizer mixture with another in crop yields; compare two slightly different soils if conditions will permit; compare

level and ridge planting in the field; market part of the crop just after harvest and another in the winter.

9. **Exercises with Sweet Potatoes.**—(1) Collect several different varieties of sweet potatoes and conduct comparative study in the laboratory. (2) Collect representative plates of sweet potatoes of at least one variety. Students should judge these plates and give reasons for their placings. (3) Collect specimens of potatoes showing stem-rot and others showing black-rot. Study these diseases in different stages until all can readily recognize them. (4) If sweet potato insects are injurious in the region collect specimens for laboratory study. (5) Treat seed potatoes with corrosive sublimate to kill spores and prevent introducing the disease into beds and fields. (6) Go to a large lot of potatoes and practise seed selection. (7) Practise grading sweet potatoes for market.

Questions and Investigations

1. To what extent are sweet potatoes produced in your county and state?
2. Describe good soils for this crop.
3. What forms of fertilizer are used?
4. What varieties of sweet potatoes are most common in your region?
5. Describe the bedding of sweet potatoes.
6. Compare good and poor plants.
7. Describe ways of preparing soil in the field.
8. Describe transplanting by hand and by machines.
9. Give the methods of field cultivation.
10. What diseases and insects are most serious? Give remedies.
11. Describe the harvesting of sweet potatoes.
12. What are principal features of the sweet potato storage house?
13. Where may the grading of sweet potatoes be done?
14. In what kinds of containers have you seen sweet potatoes marketed?

Farm Mechanics.—Make bushel measures; hauling rack for motor truck or wagon; hand planters; curing room; bins for storage; storage crates. Repair a transplanting machine; cultivator; ridger; digger.

Calculations.—1. A crop of sweet potatoes yielding 200 bu. per acre removes from the soil 29 lb. of nitrogen. How much nitrate of soda carrying 15% nitrogen is needed to supply a 12-acre crop? What will be the cost at $50 a ton?

2. The above crop removed 9 lb. phosphoric acid per acre which is to be supplied with superphosphate of 16% strength. How much is needed for the 12 acres? What is the cost at $20 a ton?

3. The above crop removes 51 lb. potash per acre, which is to be supplied with muriate of potash of 50% strength, costing $55 a ton. Find the amount needed and the cost for 12 acres.

ROOT CROP ENTERPRISES

Analysis into Jobs.—In this group are here included sugar beets and mangels. The production, marketing and use are considered. The problems in management and operation are similar. The following list of jobs includes the main teaching units and problems of these two enterprises. References are to pages in *New Agriculture*, Davis' *Farm Projects and Problems*, and to numbers of available *U. S. Farmers' Bulletins*. See *Field-Crop Enterprises*.

1. **Deciding whether or not to grow beets or mangels,** pp. 199, 202; *Farm Projects*, 233; *Bulletins*, 1637, 1645. *Local inquiry.*—(*a*) Locate the best markets for beets near you. (*b*) Make a list of the uses of root crops and their products. (*c*) Farmers will be glad to advise you regarding the advisability of growing these crops.

2. **Choosing the crop and the variety,** pp. 199, 200; *Farm Projects*, 235; *Bulletins*, 1637, 1645. *Local inquiry.*—(*a*) What local conditions would govern your choice of crop and variety. Talk with farmers regarding varieties to grow. (*b*) Compare yields from the best. (*c*) Examine the factory reports on sugar content of different varieties.

3 **Choosing soil, field and acreage,** p. 200; *Farm Projects*, 235; *Bulletins*, 567, 1475, 1514. *Local inquiry.*—(*a*) Farmers can help you choose soils best suited for these crops. (*b*) Plan your farm to make the selection of the field fit a good rotation system. (*c*) Find the sizes of fields of these crops grown in your region.

4. **Growing cover crop and providing organic matter,** pp. 28, 48, 49; *Farm Projects*, 234; *Bulletin* 1250. *Local inquiry.*—(*a*) Outline the best local rotations including these crops. (*b*) Show which of these will provide organic matter for root crops. (*c*) The expense of growing special cover crops as compared to proper rotation should be calculated, with the aid of farmers. How do the best growers provide organic matter for the soil?

5. **Securing seed and testing,** p. 200; *Farm Projects*, 235; *Bulletins*, 428, 1637. *Local inquiry.*—(*a*) The local sources of seed should be determined and compared. (*b*) The relation of testing to poor stands and to thinning should be discussed with good growers.

6. **Preparing the field and fertilizing.** pp. 199, 201; *Farm Projects*, 235; *Bulletins*, 1042, 1250. *Local inquiry.*—With the benefits of bare-fallowing in your mind, talk with farmers regarding method used in preparing soil for root crops.

7. **Planting,** p. 200; *Farm Projects*, 236–237; *Bulletins*, 1042, 1645. *Local inquiry.*—(*a*) Describe the best machine methods of planting found locally. (*b*) Compare these with hand methods, considering time, investment and results. (*c*) Find the rates for seeding practiced locally.

8. **Thinning,** pp. 200, 201; *Farm Projects*, 237; *Bulletins*, 1042, 1637. *Local inquiry.*—(*a*) How is labor secured for thinning? (*b*) Record the rates of thinning on different farms. (*c*) Talk with farmers regarding possibilities of reducing the labor of thinning: sources of seed, varieties, testing seed, soaking seed.

9. **Cultivating the crop**, p. 201; *Farm Projects*, 237–238; *Bulletins*, 1042, 1645. *Local inquiry.*—(*a*) What distances are left between rows in local fields? (*b*) What cultivating machinery is used? (*c*) How many times is each crop cultivated, before and after thinning?

10. **Irrigating and draining the soil**, pp. 41–43; *Farm Projects*, 345–349; *Bulletins*, 567, 1348, 1404. *Local inquiry.*—(*a*) Find the number of times of irrigating. (*b*) When does the irrigating give best results? (*c*) Talk with growers regarding the effects of drainage upon these crops.

11. **Controlling enemies.** *Bulletins*, 567, 1042, 1475, 1514, 1637, 1645. *Local inquiry.*—(*a*) List the diseases and insects which have given trouble locally. (*b*) How do growers prevent or otherwise control them?

12. **Harvesting the crop**, p. 201; *Farm Projects*, 239; *Bulletins*, 1042, 1645. *Local inquiry.*—(*a*) The time required per acre in harvesting heavy and light yields should be listed for a number of farms. (*b*) Compare methods with results. (*c*) Formulate the best plan as a result of this study.

13. **Storing**, p. 203; *Farm Projects*, 220. *Local inquiry.*—(*a*) Talk with growers regarding advisability of storing mangels, beets or other root crops. (*b*) Study and describe the best methods found.

14. **Using the crop and by-products**, p. 202; *Farm Projects*, 239; *Bulletins*, 1637, 1645. *Local inquiry.*—Review uses found in Job 1. Consult farmers regarding best methods of handling and using these crops and their by-products.

15. **Keeping records**, pp. 18, 19; *Farm Projects*, 32–35, 77, 78; *Bulletins*. 511, 572, 782, 1182. *Local inquiry.*—(*a*) Draw a labor form for root crop growing. (*b*) Make a list of other items of cost. Ask growers to give data or estimates of costs. Calculate the income and net returns.

CHAPTER XIII

GROWING SUGAR BEETS AND MANGELS

SUGAR beets are now abundantly grown in America for the production of sugar. A number of very large sugar factories are annually supplied with beets for sugar production. Sugar from this source made in the United States far exceeds that from sugar cane.

Regions of Growth.—Sugar beets will grow in all parts of the United States successfully. To a limited extent they are grown for use for livestock, but the growth of the crop for sugar purposes is profitable only in regions not far distant from beet sugar factories. The leading states mentioned in the usual order are Colorado, Nebraska, Utah, California, Wyoming, Michigan, Idaho, Ohio, Wisconsin. A number of other states have one or two factories each. These extend from the eastern seaboard to the Pacific.

Soils and Climates for Sugar Beets.—Sugar beets endure the cold of spring and fall and also the heat of summer fairly well. They are, therefore, adapted to a wide range of climate.

Soils of a loamy or sandy loam nature are best suited to the growth of sugar beets. Good yields are produced on soils having considerable clay or those with clay subsoils. A good percentage of organic matter in the surface soil is very beneficial in maintaining soil moisture during the growing season.

Thorough preparation of soil is necessary to success. On fields which will not wash badly after fall plowing, it is well to plow the ground in late fall and then disk it and harrow it in early spring. Where cover crops are grown they should be plowed under rather early in the spring, as green manure. This will greatly benefit the beet crop. A bare-fallow period of three or four weeks between plowing and planting times should be planned. During this period harrow the soil at least twice to cause the germination of weed seeds and kill their sprouts. This will leave the field rather free from danger of weeds and save tedious tasks of weeding after the beets are growing. Clods and rubbish should be eliminated so far as possible. A plank-drag may be used just before planting the seed.

Varieties.—Sugar beet seeds are chiefly imported from European countries. Little seed is grown in the United States. There are several varieties differing in shape, size and color of roots. Any

student or farmer growing the crop for sugar purposes should learn from the factory what variety of seed is preferred for the region. (Fig. 126.)

Planting Sugar Beets.—Seeding is usually done a little before corn-planting time. The beets will endure light spring frosts and as the seed is slow in germinating, frosts may be over before the beets are up. A common method of planting is to drill the seeds in single rows twenty to twenty-eight inches apart, leaving barely room for horse tillage between the rows. Some growers plant double rows, ten or twelve inches between the two, leaving space only between the pairs for horse cultivation. This plan requires hand work between the close rows, but more beets can be grown to the acre.

FIG. 126.—Sugar beets of the tapering form. The mark at the crown shows the soil surface and line for cutting when detopping beets. (U. S. D. A.)

Seed is drilled on the level soil by the use of special beet drills or by common garden wheel planters. Only slight covering of seed is desired. A wheel on the back of the planter should slightly press the soil over the seed to assist in bringing moisture to cause germination.

Seed germinates very poorly. Every lot of seed should be tested before planting time. Each apparent seed is really a capsule full of them. The number varies from two or three to possibly a dozen. Because of this structure of the seeds, thinning of the crop after germination is always necessary. Plant about twenty pounds of seed to the acre. Many planters soak the seeds before planting to hasten germination.

Thinning the Stand.—After the young beets are up and have

formed their second pair of leaves thinning should begin. The plants should finally stand about eight inches apart, depending on variety. Thinning is done in two operations: (a) Bunching consists of cutting out with a hoe all plants except small bunches about eight inches apart. Small, sharp hoes are preferred for this purpose. (b) Thinning the bunches is done by hand. Only one thrifty plant should be left at each place.

Thinning is chiefly done by children, but men and women also help. When whole families are employed, bunching is done by the older members and thinning the bunches by the younger. The amount of labor involved is so great that the sizes of beet fields are usually limited to correspond to the available labor at this time of year.

Cultivation.—Very often the first cultivation is made before thinning, then no growth of weeds should be allowed to get started ahead of the beets. Frequent tillage is required to keep the soil well mulched and to prevent the growth of weeds. This will also stimulate growth of the crop and cause the tops to fill the space of the rows and finally the space between the rows. Either the first or the second cultivation may be rather deep. Some growers make another cultivation of medium depth when the crop is "laid by." This throws enough soil toward the row to cover any small weeds remaining there. Later, if any large weeds are found in the field above the tops of the beets, they should be pulled by hand.

Harvesting the Crop.—Beets are harvested in the fall before serious freezes occur. The early, light, white frosts are not serious but the roots must not be allowed to freeze. Special beet lifters, resembling small plows with one prong on the moldboard, are used to lift the beets. Sometimes common turning plows are used. This should be done when the soil is not too wet. The beets are then gathered together and thrown into piles with one row of piles to about ten rows of beets. The next step is topping the beets. With special knives or with large butcher knives or small corn knives, the tops are cut from each beet at a single stroke. The beets from four piles are thrown into one. Here the piles may be covered with tops or other rubbish to prevent freezing until they can be hauled or shipped to the factory. Beet tops are used for feeding livestock.

The prices paid for sugar beets depend upon the percentage of sugar. Samples are taken from each lot of beets delivered at any one time. These samples are tested for sugar content, which may vary from about 15 to 20 per cent.

Extracting the Sugar.—At the factory beets are purchased in large quantities and usually piled in the open where they may freeze, but are used as rapidly as possible. If they are kept frozen until used no damage will result from freezing.

The beets are washed, trimmed, sliced, and the juice extracted with hot water. Lime and other materials are used in purifying the juice. Portions of condensed juice which do not crystallize are used for molasses. Centrifugal machines are used to separate it from the sugar crystals. The pulp from which juice has been extracted is dried, bagged, and sold for stock feed. It is valuable for dairy cows, being soaked before feeding. It serves the same purpose as good silage in the ration.

Mangels

Students and farmers can produce a few acres of mangels with profit. Their chief use is for feeding livestock. They are excellent for dairy cows, for sheep and for swine. In the feeding ration they take the place of other succulent feeds. They are also often substituted for corn in the ration. Yields of ten or fifteen tons of roots per acre are quite common.

Regions for Mangels.—Because of the labor involved in growing this crop successfully it is not much grown in America in corn-growing regions. It thrives well further north and at higher altitudes than corn. Ten acres of silage can be produced with less acreage than the same amount of feed in the form of mangels.

Mangels and Sugar Beets Compared.—The roots of these two crops differ chiefly in the following respects: (1) More common varieties of mangels grow with one-half or more of the roots above the surface making them easy to harvest (Fig. 127), while the sugar beets are chiefly below ground. (2) In shape mangels are usually larger near the surface of the ground or central belt, while sugar beets are largest near the crown and taper from there downward. (3) In color of flesh the sugar beet is commonly white or nearly so. Mangels are seldom white, being reddish or yellowish. (4) In color of skin mangels are commonly red or yellow, but may be white, purple, or nearly black, while the sugar beet is usually white or yellowish. (5) In weight of roots mangels average four to six pounds, sugar beets one to one and a half pounds. (6) Mangels contain about 88 per cent of water and less than 6 per cent of sugar. Sugar beets average 80 per cent of water, 16 or 17 per cent sugar. (7) Mangels yield 15 to 30 tons per acre, sugar beets half as much.

The Crops Compared in Culture.—These crops are much alike in soil requirements and the methods of planting, thinning, and cultivation. The rows of mangels are placed twenty-eight to thirty inches apart and thinned to about ten inches apart in the row. Less care is exercised in thinning, more of it being done with hoes. In harvesting mangels a furrow is thrown away from one side or both sides of the row. They are then easily pulled by hand and thrown into windrows or piles.

For storage they are usually put in pits or cellars to keep them

FIG. 127.—Mangel-wurzel beets at harvest time. Note the proportion of root grown above ground. (Lewis' Productive Poultry Husbandry.)

from freezing. There is usually little loss from rotting in cold climates. They are fed in winter chiefly to dairy cattle.

Trips, Surveys, Exercises, Projects, and Problems

1. **Field Trips.**—If sugar-beet factories are in the region they should be visited when running. Visit barns where mangels or other root crops are used by farmers for feeding livestock. Observe methods of storage, slicing, and otherwise preparing them for feeding. If possible, study methods of planting, thinning, harvesting, and topping.

2. **Neighborhood Survey.**—In sections where sugar beets or mangels are commercially grown make a survey using such questions as the following: Rotation of crops; crop preceding this one; time of plowing; other soil preparation; character of soil; varieties; distances of planting; implements used; seed per acre; rate of thinning per man-day; number of cultivations; how harvested; yields; percentage of sugar; prices, if sold; storage for mangels; costs per acre.

3. **Problems** based on the survey may be along such lines as the following: Maximum, minimum, and average yields; maximum, minimum, and average costs per acre; profits per acre; variations in sugar content; percentage comparisons between soils and varieties.

4. **Charts** may be made by students on such topics as those suggested for the problems. From the latest census report compare acreages for

sugar cane and for sugar beets. Make percentage comparisons between them in yields of sugar per acre and profits in growing.

5. **Picture placards** may be made up from pictures from factories, seed catalogues, bulletins and agricultural journals. Photographs may be taken of students' projects, of different varieties, of various field operations, such as harvesting and loading for market. Various storage methods for mangels may be shown.

6. **Debates and discussions** will be profitable on several topics: "Sugar from beets is produced cheaper than sugar from sugar cane." "Beet sugar *vs.* cane sugar for home purposes." "The United States was justified in encouraging sugar beet growing by a bounty on sugar at first." "One hundred miles is not too far to ship sugar beets to a factory." "Mangels are more profitable than silage for production and feeding."

7. **Projects** in the growth of sugar beets or mangels may vary from one-half to two acres. At thinning time some extra labor may be employed. The scope should include everything from the preparation of the soil to the marketing or using the crop. The report of the project should include all points such as those mentioned for the above survey.

8. **Special trials in projects** may include thinning at different distances and at different times; early and late planting; different kinds of soil; different fertilizers; different varieties; variations in time of harvest.

Questions and Investigations

1. Give the chief regions for growth of beets for sugar.
2. Describe soils for sugar beets.
3. Describe sugar beet seeds and tell how to plant.
4. Give reason for thinning and tell how to thin.
5. Describe cultivation of sugar beets.
6. How is the crop harvested?
7. Outline the management after harvest.
8. Contrast mangels with sugar beets.
9. Compare their culture.
10. Give uses of mangels.

Farm Mechanics.—Make hand drills; toppers; hauling rack; unloading crane. Repair planter, cultivator, root lifter.

Calculations.—1. How much sugar is yielded by a field of 12 acres if 12 tons of topped beets are harvested from an acre and the sugar test at the factory is 19 per cent?

2. Another field of 12 acres, infested with nematodes, yields only 6 tons of roots per acre and the sugar test is 14 per cent. Find the loss in money due to this enemy if 1½¢ a lb. is allowed for sugar content.

3. A crop of 15 tons of sugar beets removes from an acre 78 lb. of nitrogen. How much sulfate of ammonia, testing 20 per cent nitrogen, will be used to supply the need if no green manure is used?

4. If the crop in problem 3 removes 24 lb. acid phosphate, how much superphosphate, testing 16 per cent, is required to supply the need?

5. This crop also used 96 lb. of potash which is to be supplied by applying kainit testing 12 per cent potash. Find the amount to be applied per acre if half the amount is to come from the clay in the soil and subsoil.

COTTON ENTERPRISE

Analysis into Jobs.—The main teaching units in the cotton enterprise are included in the jobs here given. References are to pages in *New Agriculture,* Montgomery's *Productive Farm Crops,* and to numbers of *U. S. Farmers' Bulletins.* See also cotton books by Burkett and Poe, and by Mercier and Savely, and *Southern Field-Crop Enterprises.*

1. Deciding whether or not to grow cotton, p. 205; *Farm Crops,* 203–206, 218. *Local inquiry.*—(*a*) Ask cotton growers their chief reason for continuing to grow cotton. (*b*) Get their arguments against this crop. (*c*) Compare local yields and prices with the averages for your state. (*d*) What local difficulties such as enemies, distance from gin or unfavorable soil can you find?

2. Choosing type and variety, pp, 204–209; *Farm Crops,* 207–210; *Bulletin,* 1432. *Local inquiry.*—(*a*) Make a list of all of the varieties grown locally; of what type is each? (*b*) Ask the growers, gin operators, county agent and others to compare these varieties in yields of lint and seed. (*c*) Get opinions regarding the adoption of one community variety.

3. Deciding acreage, soil and field, pp. 46 48, 49, 206; *Farm Crops,* 220; *Bulletin,* 1015. *Local inquiry.*—(*a*) Make a list of the acreage of many cotton growers. (*b*) Which of these growers are owners or tenants? (*c*) Find the capital required to finance fields of different sizes. (*d*) What local soils are considered best for cotton? (*e*) What crop usually precedes cotton?

4. Starting a cover crop and providing organic matter, pp. 46–48, 49; *Bulletin,* 1250. *Local inquiry.*—(*a*) What fraction of the farmers grow cover crops? (*b*) What amount of barnyard manure is applied to cotton fields? (*c*) How many of them turn under a cover crop or other crop to supply green manure?

5. Procuring seed. Selecting in field, pp. 31, 32, 209; *Farm Crops,* 210, 215; *Bulletins,* 1384, 1432. *Local inquiry.*—(*a*) Make a list of local growers and the way each procures cotton seed. (*b*) Find their arguments for and against field selecting of seed.

6. Buying and mixing fertilizer, pp. 27, 44, 45, 207, 208; *Farm Crops,* 36, 215, 221–225. *Local inquiry.*—(*a*) Calculate the amount of each material to buy for fertilizing a 20-acre field of cotton by the best ratio found. (*b*) Find the local prices of fertilizer materials, mixed and unmixed.

7. Keeping records, pp. 18, 19; *Bulletins,* 511, 572, 782, 1182. *Local inquiry.*—(*a*) Ask several growers regarding the cost of each of the main operations in growing cotton. (*b*) Select the truest estimates and find the total cost of production.

8. Testing and treating seed, pp. 66, 67, 91; *Bulletins,* 428, 948. *Local inquiry.*—(*a*) Ask farmers for points in favor of or against testing and treating cotton seed before planting. (*b*) Delint a lot of seed with strong sulfuric acid and get a farmer to try it in a machine planter. (*c*) Calculate how much of the expense of thinning can be saved by delinting seed.

9. Preparing soil. Spring fallowing, pp. 40, 41, 42, 50, 51, 59, 70, 206; *Farm Crops,* 225, 226. *Local inquiry.*—(*a*) How many weeks before planting do local growers plow the soil. (*b*) How many of them harrow several times all through this interval?

10. **Planting and fertilizing,** pp. 209–211; *Farm Crops*, 38, 221, 227. *Local inquiry.*—(*a*) Describe the kinds of planters found. (*b*) Calculate the saving when a fertilizer box is carried on the planter. (*c*) Find the rates of application of fertilizer for cotton. (*d*) Try to find a relationship between the method of preparing soil and dates of planting. (*e*) Find the amount of seed used per acre. (*f*) What farmers apply some fertilizer after the crop is growing?
11. **Cross-harrowing the cotton,** pp. 50, 72, 73, 182, 212; *Farm Crops*, 225. *Local inquiry.*—(*a*) Ask farmers who do not cross-harrow cotton why they do not. (*b*) Ask those who do for their reasons. (*c*) Ask farmers to compare the cost of cross-harrowing twenty acres with the cost of cultivating it row by row.
12. **Hoeing. Chopping,** p. 211; *Farm Crops*, 225, 229. *Local inquiry.*—Make a list of cotton growers and give the estimate of each for the man-hours used in hoeing and in chopping or thinning cotton.
13. **Cultivating,** pp. 74, 75, 211, 213; *Farm Crops*, 225, 229. *Local inquiry.*—Describe each of the implements used by local cotton growers for cultivating between rows.
14. **Controlling boll weevils,** pp. 211, 212, 214; *Farm Crops*, 234, 235; *Bulletins*, 501, 1329, Weevils. *Local inquiry.*—(*a*) Find how many growers plow under or otherwise destroy cotton stalks in the fall. (*b*) How many pursue clean-up campaigns each fall or winter? (*c*) What special spacing of cotton do growers practice to help control boll weevil? (*d*) Ask them what methods are used for the early production of the crops. (Page 212.) (*e*) Which ones pursue a dusting campaign with arsenical poisons?
15. **Controlling other enemies,** pp. 212, 213; *Farm Crops*, 224, 225, 235, 236; *Bulletins*, 831, Spiders; 1345, Root-knot; 1595, Worms. *Local inquiry.*—(*a*) Find what insects and diseases have affected cotton locally. (*b*) How do growers control boll worms? Root-rot? Root-knot? Anthracnose?
16. **Picking cotton,** pp. 213, 214; *Farm Crops*, 231. *Local inquiry.*—(*a*) Find the rates paid for picking. (*b*) Talk with farmers regarding the number of pickings made and get reasons for each practice.
17. **Ginning cotton,** pp. 214, 215; *Farm Crops*, 206–232; *Bulletin* 1384. *Local inquiry.*—(*a*) Study how and why growers store seed cotton before ginning. (*b*) Study the average cost of ginning. (*c*) Calculate the proportion of seed to lint from different varieties and from different farms.
18. **Marketing cotton,** pp. 215, 216; *Farm Crops*, 233; *Bulletins*, 1384. 1144. *Local inquiry.*—(*a*) Find farmers' reasons for and against coöperative marketing of cotton. (*b*) Find who grades the cotton grown in your region; what grades are grown? (*c*) Study the uses of a federal or community warehouse system.
19. **Selling cotton seed,** *Farm Crops*, 216, 217; *Bulletins*, 1232, 1661. *Local inquiry.*—(*a*) Compare the prices of gin-run seed with the prices paid for cotton seed for planting. (*b*) Ask farmers how they could secure the latter prices for their seed.
20. **Destroying cotton stalks,** pp. 210, 211; *Farm Crops*, 225. *Local inquiry.*—(*a*) Find how many farmers realize that boll weevils live over winter in the stalks. (*b*) Find how many destroy the stalks properly in the fall.

CHAPTER XIV

COTTON ENTERPRISE

COTTON is the leading fibre crop of the world, being used for more purposes than any other fibre. In money value it stands near the head of the list of the crops of the world.

Importance in the United States and in Your Region.—Twelve southern states grow more than two-thirds of the cotton fibre of the world. (Fig. 128.) Peoples of all the countries use products from the American-grown cotton. Exports of cotton and cotton products exceed all other agricultural products combined.

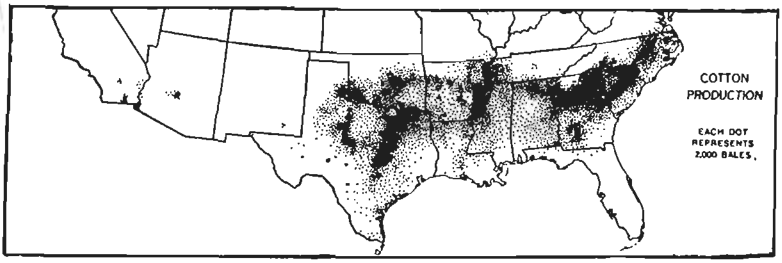


FIG. 128.—Distribution and production of cotton. (U. S. D. A.)

Leading cotton states in order of usual production are Texas, Oklahoma, Mississippi, Georgia, Arkansas, Alabama, South Carolina, Louisiana, North Carolina, Tennessee.

From the latest census report ascertain the acreage and the amount of cotton grown in one county and one state in which you are interested. Compare these with others.

Regions and temperatures for growing cotton are fairly well indicated by the list of states mentioned. Climates having about one hundred and twenty days between the last spring frosts and early fall frosts are necessary for production of good yields of cotton. Nights and days should both be warm throughout a large part of the growing season. Moist soils and climates produce better yields than dry. Recently efforts have been made to grow cotton profitably under irrigation in Arizona and elsewhere.

Types of cotton are of several kinds (Fig. 129): (1) Short-staple upland cotton is far the most common. (2) Long-staple

upland cotton is second in importance. (3) Sea-island cotton important on the islands and adjoining main lands of South Carolina, Georgia, and other Atlantic and Gulf coasts.

Foreign types are India cotton, which has short staple; and true Peruvian or Egyptian cotton, which has long staple of a brownish color. This latter has been most used in irrigated regions of Arizona.

Length of Staple.—Other things being equal, the length of staple chiefly governs the market prices. Short-staple cotton varies from three-fourths to one and one-eighth inches (Fig. 130); long-staple from one to one and five-eighths; sea-island cotton, one and five-eighths to two inches.

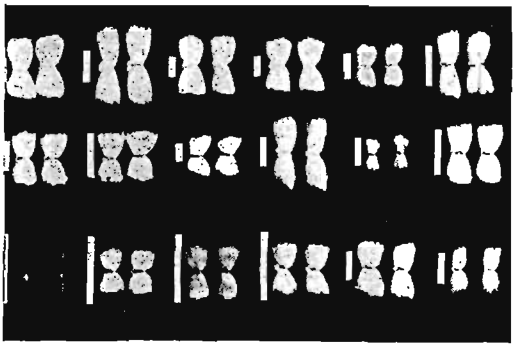


Fig. 129.—Combed seed cotton, showing comparative length, color, uniformity, and quality of staple of different varieties. (Texas Station.)

Soils for Cotton.—Best crops are produced on rich loams, but soils used in the production of cotton vary from heavy to light. If conditions of temperature and rain fall are favorable cotton will adapt itself readily to many types of soil. The cotton plant has a tap root and is a deep feeder. The soil, therefore, should be deep. Enough humus should be in the soil to cause it to hold moisture well. Green manure should be provided either by suitable rotation or by the use of cover crops plowed under. Light, sandy soils poorly drained seem to encourage the rust of cotton. Potash fertilizer is frequently used to reduce this disease.

Rich soils of river bottoms sometimes produce coarse plants with small yields of cotton. Such soils should first be used for corn or other crops to reduce their nitrogen supply.

Preparation of soils for cotton should begin the fall before the crop is to be planted. Because of the prevalence of boll-weevil in most cotton-growing regions, fall plowing to destroy the winter hiding places of this insect is practised. As this plowing is often quite late fall grains with winter vetch are sown as winter cover crops. One bushel of rye and one peck of hairy vetch per acre may be used. This covering prevents washing and leaching, fur-

nishes winter pasture and supplies a good growth of green manure to plow under in the spring. If the growth be light it may be disked into the soil. Many growers, however, growing the crop on poorly drained fields, bed up the rows by throwing two furrows

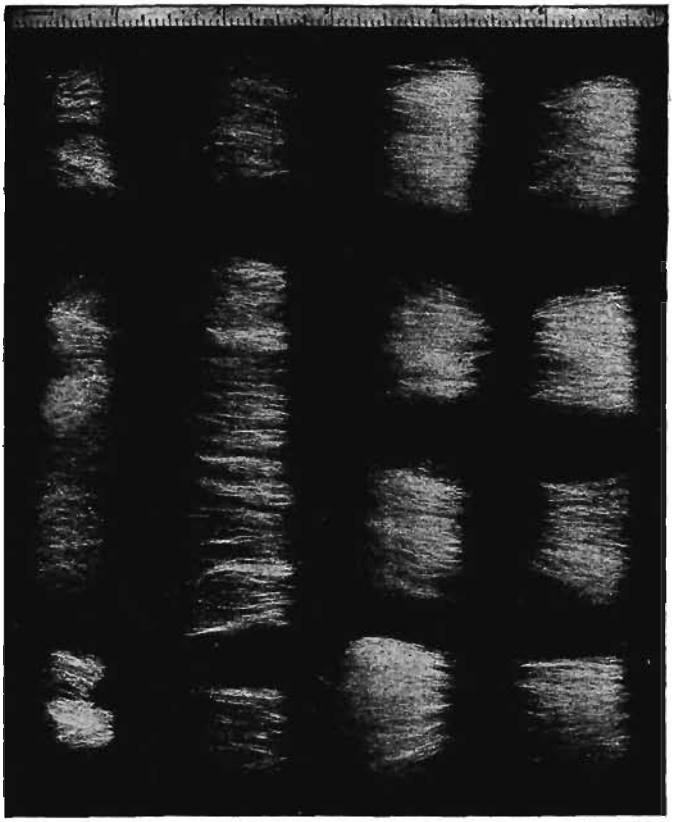


FIG. 130.—Short staple upland cotton in four grades or lengths of lint. The relative amounts are indicated by the masses. (Johnson & Johnson.)

together. The tops of these ridges are usually levelled somewhat with a harrow or plank-drag before planting time. The middle is often left undisturbed until after the crop is growing.

The best growers usually prepare a level field for seeding. More thorough preparation is thus attained and less cultivation will be necessary later.

Fertilizers for Cotton.—Much commercial fertilizer is used in growing the American cotton crop. A bale of lint cotton, five

hundred pounds, corresponds on the average to one thousand pounds of seed and a ton of stalks. Such a crop would remove from an acre of land eighty-four pounds of nitrogen, fifty-seven of which would be in the stalks and only one and a half in the lint; thirty-three pounds phosphoric acid, twenty of which would be in the stalks and one-half pound in the lint; fifty pounds of patash, thirty-six of which would be in the stalks and two and a half in the lint. From this it is seen that if the stalks are not destroyed and if the fertilizer of the seeds be returned to the soil, very little plant food is removed by the crop of lint.

Under common forms of crop management the seed and lint are both removed and the stalks are often burned. This burning removes the nitrogen but does not remove phosphoric acid and potash.

If cotton seed be used for the extraction of oil and the cottonseed meal is returned to the land the three fertilizer ingredients are not lost from the soil, the removal of the oil taking away none of the fertility. The removal of oil from the seed makes the residue more readily available as plant food. It does not pay to use whole cotton seed as fertilizer.

As a good mixture for cotton to be grown on worn uplands the Georgia Experiment Station recommended:

Cottonseed meal	671	pounds
Acid phosphate	190	"
Kainit	296	"

Use four hundred to eight hundred pounds of this mixture to the acre. Nitrate of soda is usually more economical than cottonseed meal, less than half as many pounds being required.

Sandy soils need more potash than heavy soils. Soils rich in organic matter usually need less nitrogren than others. Much fertilizer may be saved by using green manure and barnyard manure.

Selecting a Variety.—The main types are Cluster, Semi-cluster, Peterkin, Early King, and Big-boll. The markets now demand longer staple than formerly. The Georgia Station recently recommended these six varieties listed in order of greatest money value per acre first: Long staple—Delfos 6102, Deltatype No. 5, Super-seven. Short staple—Lightning Express, Cook 588, College No. 1.

Tests in Oklahoma ranked 12 varieties in money value per acre as follows. The length of lint in inches is placed by each: Okla. Triumph 44 ($1\frac{1}{16}$); Trice (1); Acala 5 ($1\frac{1}{16}$); Half-and-half ($\frac{13}{16}$); Bennett's ($1\frac{1}{16}$); Lone Star ($1\frac{1}{16}$); Mebane (1); Cook's Improved (1); King ($\frac{15}{16}$); Express ($1\frac{1}{8}$); Cleveland Big Boll ($\frac{15}{16}$); Rowden (1).

For regions or soils where cotton is likely to be attacked by wilt disease, the grower should choose a wilt-resistant strain. Several such strains have been developed by experiment stations. Where boll-weevil control is difficult choose a very early variety with short-jointed limbs. Before choosing varieties ascertain what ones are most successfully grown in your region. Ask growers, county agents and your experiment station.

Field Selection of Seed.—If your cotton-growing project has been determined early enough, the seed for next year's planting should be selected from the field before the main crop is picked.

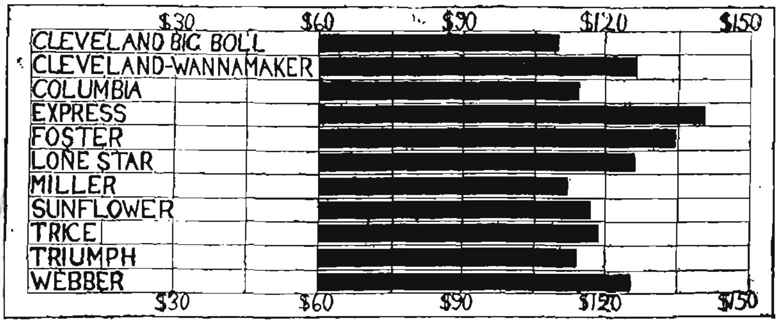


FIG. 131.—Comparative total values of seed and lint per acre, of eleven standard varieties of cotton tried at the Mississippi Station.

Walk through a good field with a picking bag and select according to the following points (Fig. 132): (1) High-yielding plants; (2) fruiting limbs borne rather low; (3) internodes short; (4) bolls, large; (5) earliness of maturity; (6) disease resistance; (7) large percentage of lint; (8) storm resistance; (9) long fibre.

When seed is thus selected it should be ginned separately and stored in a dry place.

Purchasing Seed.—If cotton seed must be purchased obtain pedigreed seed from reliable growers. Increased yields will far more than pay the difference in cost of seed. Thoroughly cleaned and heavy seed should be chosen.

Planting Cotton.—Plant after all danger of the last spring frost is over, and after the soil is warm. Most of the crop is planted in April, but in the northern cotton regions much of it is planted in May. If soil conditions are favorable early planting will hasten the crop and avoid some of the loss due to boll-weevils.

A bushel of seed contains 120,000 to 150,000 seeds. When fields are planted with the rows four feet apart and the plants are to stand twelve inches apart in the row, there will be less than 11,000

plants per acre. But as many seeds fail to germinate and as many of the plants are weak, growers usually plant a bushel or more of seed per acre. Good seeds and good planters would save much in the purchase of seeds. The Arkansas Station has, by removing

FIG. 132.—A typical cotton plant of the Dixie wilt-resistant variety. Note the short internodes and the compact habit of the plant. (U. S. D. A.)

all lint from seeds with sulfuric acid, facilitated even spacing of seeds and avoided the chopping of cotton. (Bul. 181.)

Planters dropping one seed in a place and planting one row at a time are in common use. (Fig. 133.)

Distance between rows varies from three and one-half feet on poor uplands to four, five, or six feet where soils are richer. Seed may be saved by treatments which will prevent the seeds from clinging together in the planters. The fuzz is pasted down by treating the seed with moistened flour or clay to which has been added a little ashes.

For early planting shallow covering is best. When soils are drier and warmer more covering is allowed, about two inches.

Fertilizer boxes are often attached to the planters so that fertilizer may be spread at planting time.

Chopping.—Most cotton growers practise chopping or thinning the stand with hoes after the first cultivation. The object is to leave only one plant in a place and to leave them at the desired distances in the row, eight to twenty-four inches.

Cultivation.—This should begin as soon as the crop is planted, to save moisture, to warm the soil and to prevent the growth of weeds. A spike-tooth harrow should be used just after planting and again just after the plants are up. Such broadcast tillage gets

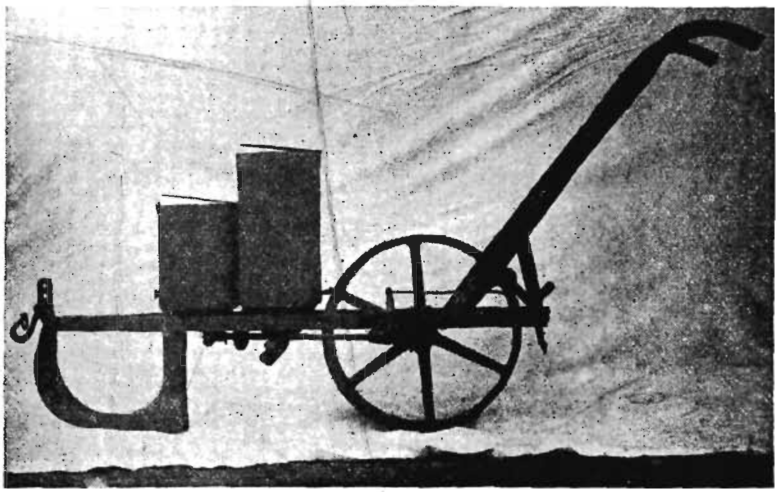


FIG. 133.—Combination planter and fertilizer distributor, drawn by one horse. (Florida Station.)

closer to the plants, prevents crusting of the soil and prevents the growth of weeds in the rows.

For the first cultivation between the rows, various forms of cultivators are in use. (Fig. 134.) Fenders are often attached at this time to prevent covering of plants with soil. After chopping, soil is usually worked toward the rows to replace that removed by the hoes. Suitable cultivators should be used frequently enough to maintain a fine soil mulch on the surface and to prevent the growth of grasses and weeds. After each heavy rain there is danger of the soil becoming crusty unless cultivation follows promptly.

Boll-weevil.—This insect destroys hundreds of millions of dollars' worth of cotton annually. The adults live over winter, hiding in cotton stems and other places when cool weather (or fall) begins. Most of these die during the winter. When warm weather begins the following spring these few beetles become active and fly to cotton fields. Each female lays over one hundred eggs. These are deposited on squares where the larvæ

hatch and feed inside where the young seeds and cotton are being formed. (Fig. 136.) Within two or three weeks these will have again laid eggs on other squares. This rate of multiplication continues until the end of the season. More than twelve million progeny may be produced in one season beginning with a single female.

Control of Boll-weevil.—Several important practices should be followed each year: (1) Destroy cotton stalks as soon as picking is over. This is best done by stalk cutters and by plowing under the stalks. (2) Destroy weevils in all hibernating places by general clean-up methods. (3) Force early production of crops. (4) Space plants closer in the row

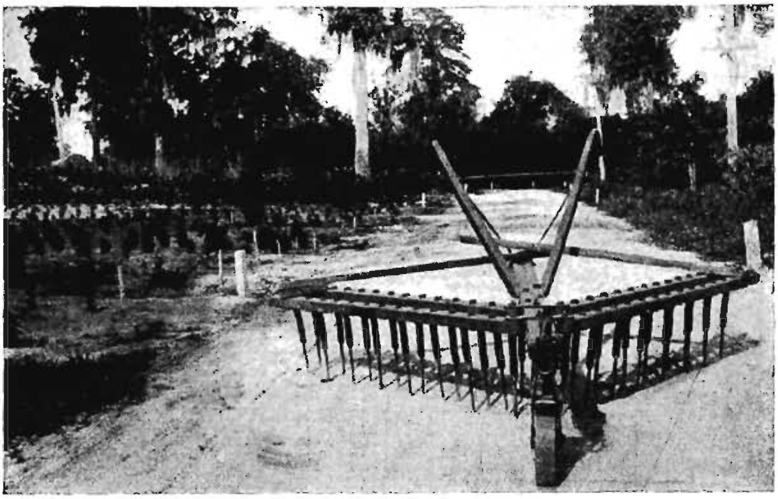


FIG. 134.—Adjustable weeder used for light cultivation when the plants are small. (Florida Station.)

to hasten maturity. (5) Space rows far enough apart to cause fallen squares to wither quickly in the bright sun. (6) Use chains on cultivators to drag fallen squares into the middles to wilt. (7) Cultivate often to bury many fallen squares. (8) Dust with arsenate of lead mixed with lime dust, 1 to 50. The dusting should be done at night or when the plants are wet with dew or with light showers of rain. Such poisoning is profitable only when yields of about one bale to the acre or more would be expected were the boll-weevil controlled. A number of applications are necessary to protect all new squares from damage.

Methods of Securing an Early Crop.—As the boll-weevil multiplies rapidly an early crop will avoid much of the damage from this pest. The chief means of securing an early crop are the following: (1) A warm seed bed produced by a bare-fallow period preceding planting; (2) well-drained soil; (3) selecting seed from early-maturing plants; (4) using early or quick-maturing varieties; (5) planting as early as the soil is well warmed; (6) use of plenty of commercial fertilizers; (7) cross-harrowing; (8) frequent cultivation; (9) closer spacing of plants in the rows.

Cotton Boll-worm.—This insect is more familiar to many people in the form of the corn ear-worm or tomato fruit-worm, which are other names of the same insect.

Rotation of crops is one of the best remedies. Cotton growers often grow trap crops of corn in the cotton or around it. These insects prefer corn to cotton. After the corn is badly infested it may be cut for fodder and many of the insects thus killed.

The Pink Boll-worm.—Recently this insect has done much damage in cotton fields of Texas. The damage where this insect has appeared has been more severe than from any other enemy. Methods of control are thus far little understood and further investigations are being made.

Cotton Diseases.—Probably the worst disease is cotton wilt, which attacks the roots and chokes the water supply from the plant. Plants often turn yellow and die. Choosing cotton which is wilt resistant is the best remedy. This is a strong argument in favor of field selection of seed.

Root-rot is particularly serious in the heavy soils of Texas. It attacks not only cotton but other tap-rooted plants, such as nut trees, some legumes and others. Rotation of crops and deep fall plowing are recommended.

Fig. 135.—View of a modern, electric cotton gin. (Courtesy the Murray Company, Dallas.)

Grow in the rotation crops with shallow fibrous roots, such as small grains, corn and grasses.

Root-knot is a disease causing knots on the roots, which stifle the feeding powers. It is caused by nematode worms, similar to those attacking soybeans, cowpeas, crimson clover, burr-clover, melons, tomatoes, tobacco, pecans, peach trees and raspberries. As rotation is the chief remedy none of these crops should be grown in the rotation when the disease is present. Use small grains, sorghum, and corn in the rotation. This disease is much more likely to be serious on light, sandy soils. Heavy liming will help to eradicate nematodes.

Cotton anthracnose affects the bolls causing rot and pink coloration. It is common throughout the cotton belt and does much damage, being worst in damp weather. Wind and insects help to spread the disease. Cotton seed also carries the spores and may become infested at gins. Never grow cotton two years in succession in soils where it has occurred. The use of winter cover crops helps to check its damage. Use varieties which are least susceptible and select seed cotton each fall from healthy portions of the field.

Harvesting.—A number of machines more or less successful for picking cotton have been invented. Their chief trouble is the collection of trash which is difficult to remove from the cotton.

Most of the crop is still picked by hand. It is the most laborious task in cotton production. One picker may average 200 pounds of seed cotton per day. Seven or eight days are required to pick the equivalent of one bale of lint cotton. The cotton does not ripen uniformly and several pickings are usually necessary. Harvest begins in September and continues until winter. Much of the picking is done by colored people—men, women, and children

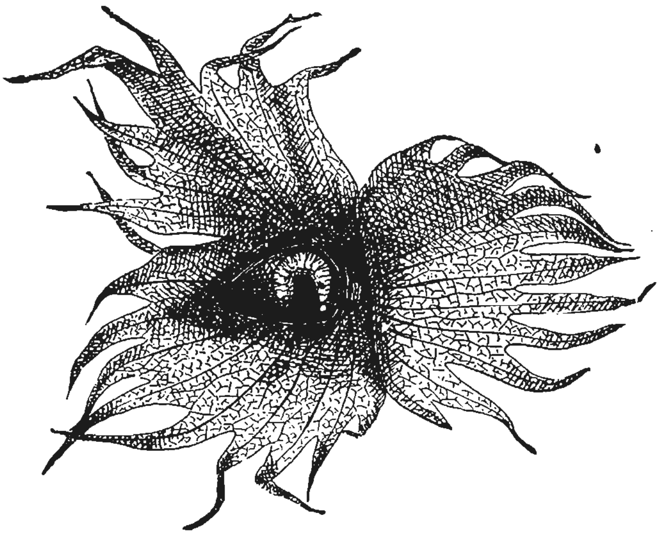


Fig. 136.—Larva of boll-weevil, natural size, lying in a cotton square. (Smith's Economic Entomology.)

—each carrying a picking bag to hold the seed cotton as it is gathered from the bolls.

Average yields of cotton are less than one-half bale of lint per acre, but the most productive fields will grow two bales or more.

Ginning.—After picking, the cotton is ginned. (Figs. 135, 137.) Seed cotton is hauled from the fields to a neighborhood ginnery. Suction pipes lift it from wagon boxes to the gin stand where it is fed over revolving circular saws having very fine teeth to separate the lint from the seeds. Stationary teeth or combs prevent the seeds from passing along over the rapidly revolving set of saws. The lint cotton comes from the gin in large flakes or rolls and is ready for the press. Powerful presses are used in baling the cotton.

A little coarse burlap or other bagging is pressed around the bales under the bands.

The next step is to compress large bales into small ones before shipment. The compressor greatly reduces the bulk of the bales.

One 500-pound bale of lint cotton will correspond to about 1,000 pounds of seed ginned from it. This should allow about 75 pounds of linters and trash, 400 pounds of hulls, 150 pounds of oil and 375 pounds of cottonseed meal.

Seeds.—Formerly much of the cotton seed was discarded at

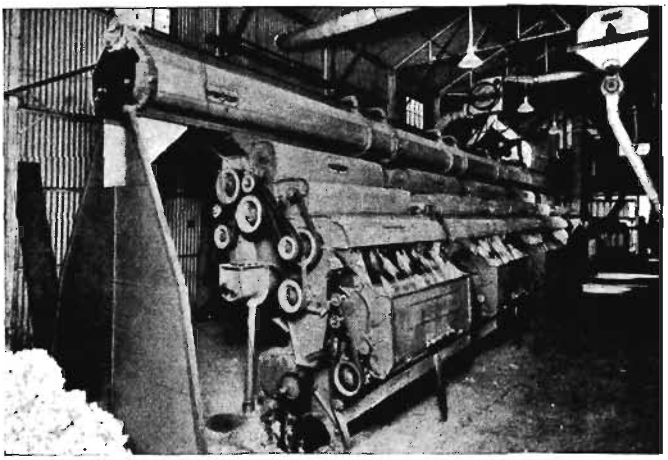


FIG. 137.—Inside of a modern, electric cotton gin. (Courtesy the Murray Company, Dallas.)

the gin as a waste product or returned to the farmer to be fed whole or to be used for fertilizer. Now most of the seeds go to oil factories. Before extracting the oil the fine linters and hulls are removed. The linters are used in cheap mattresses and poor grades of cloth. The hulls are used for fertilizer and for stock feed. When the oil is pressed from the inner portion of the seeds the cottonseed cake is ground into meal for use as feed and fertilizer. The oil is used in making salad oils, lard substitutes, oleomargarine, soaps and the adulteration of paints

Market Grades of Cotton.—At both local and central cotton markets, buyers take samples from the bales and determine the grades before buying. Enormous wastes from each bale result from this common practice, before the bales reach the factory. Federal regulations have been promulgated to establish standard grades and

allow each bale, when once graded, to be sold and handled under its original grade. Seven principal market grades of cotton have long been in use. There are sub-divisions of each principal grade. These are designated by prefixing terms with definite meanings. Most of our American upland cotton falls within the grades of middling fair and middling. The seven grades and sub-divisions are as follows:

1. Fair	3. Good middling	5. Low middling
Barely fair	Barely good middling	Barely low middling
Strict middling fair	Strict middling	Strict good ordinary
Fully middling fair	Fully middling	Fully good ordinary
2. Middling fair	4. Middling	6. Good ordinary
Barely middling fair	Barely middling	Barely good ordinary
Strict good middling	Strict low middling	Strict ordinary
Fully good middling	Fully low middling	7. Ordinary
		Low ordinary
		Inferior

Under the Federal warehouse regulations producers are assisted in obtaining credit on their baled crop and are not so often required to make immediate sales when prices are apt to be at the lowest ebb. Cotton graded and stored in warehouses is held as security for loans made either from national funds or from banks. (See U. S. Bureau of Markets bulletin.)

Optional Studies.—In the early historic times cotton was cultivated. It probably originated in India or China. Good qualities of cloth were woven by the ancients of India. From Asia the plant was introduced into Europe at the time of Alexander III. Before the discovery of America cotton was grown by the natives of Mexico and South America. This was a different species from that of the Old World.

In colonial times cotton cultivation was started in Virginia soon after the establishment of that colony. Its importance as a money crop in America has grown rapidly since that time.

By the early hand methods it took a day for one person to separate a pound of lint from its seeds. In 1792 the cotton-gin was invented by Eli Whitney. The result of this invention and the improvements following it greatly stimulated the production of cotton. Two types of gins are in use now. The saw gin most commonly used throughout our cotton belt represents the first invention. A sixty-saw gin-stand is capable of ginning a 500-pound bale of lint per hour. The other type of gin is known as the roller gin and is used for Sea Island cotton having naked seeds. The rollers are not so apt to break the long fibres as are the saw gins.

Surveys, Trips, Exercises, Projects, and Problems

1. **A local cotton survey** should include such points as the following: Size of fields; soils; rotations; cover crops; commercial fertilizers; home mixing; bare-fallow before planting; level or ridge planting; selection of seed; amount per acre; amount of chopping necessary; cross-harrowing; number of cultivations; damage from boll-weevil; how combatted; number of dustings; damage from other enemies; number of pickings; yields; prices for seed and lint; grades secured; financing the crop; holding the product; how marketed.

2. **Cotton Problems.**—From the survey and from the census report, solve such problems as the following: (1) A man increased his cotton yield from 250 up to 800 pounds per acre by properly selecting seed. The extra cost for such work may be estimated at $1 per acre. If he grows twenty acres of cotton, what is his profit due to seed selection, the selling price being twenty cents per pound? (Consider the extra work of picking and ginning as balanced by the increased seed yield.) (2) Compare the average yields of your region with those of the county and the state. (3) Calculate the profits due to local seed selection. (4) Make a similar problem based on the use of commercial fertilizers. (5) Calculate the total expense and total income of the cotton crop of one tenant farmer. Determine from this the labor income for himself and family.

3. **Cotton charts** may be on such subjects as those given here: Items of cost in growing cotton; points to observe in field selection of seed; methods of fighting boll-weevil; losses due to the boll-weevil and each of the local enemies; elements in early production; varieties arranged by local popularity; a balance sheet of one producer.

4. **Pictures for placards** may be taken by photographing views at the gin, sampling and grading; views at an oil factory; steps in growing the crop.

5. **Cotton samples** should be mounted on cards showing length of fibre for different grades of cotton and for different types. Write to growers or schools in other places for some of these samples. (Fig. 129.) Collect samples of cotton-seed products from oil factories or from the markets.

6. **Debates** may be held on such subjects as the following: "Resolved that field selection of seed pays better than other means of securing seed." "Resolved that early production of the cotton crop is the best method of combatting the boll-weevil." "Resolved that the credit system in the cotton belt should be discouraged or abolished." "Resolved that rotation and cover crops are more valuable than commercial fertilizers in growing cotton." "Resolved that a high tariff on cotton does not benefit the grower."

7. **Field Trips.**—Visit fields where bare-fallow and cross-harrowing and level culture are practised. In the fall before cotton is picked students should have practice in field selection of seed cotton. Trips to gins, balers, compressors and oil factories will prove profitable if well planned.

8. **Projects in cotton growing** should be planned to include all the steps and the best methods beginning with fall selection of seed or with the planting of fall cover crops and continuing until the crop is marketed or stored. If help is employed at picking time a good size for a student project may vary from one to five acres.

9. **Trials with Projects.**—Comparative trials should be made to demonstrate such points as the benefits of field selecting of seed; the use of cover crops; the bare-fallow period before planting; the level methods of planting; the uses of early varieties; frequent cultivation; available forms of fertilizers; dusting for boll-weevil.

Questions and Investigations

1. Tell what you can of the importance of cotton crop locally and otherwise.
2. Tell of the regions and temperature for cotton growth.
3. What is meant by length of staple?
4. Give lengths for different types.
5. Give characteristics of good cotton soil.
6. Describe good ways of preparing soils.
7. Discuss the use of fertilizer for cotton.
8. What varieties are best for your region? Mention largest yielders elsewhere.
9. Give reasons and directions for field selection of seed.

10. Give directions for planting. Why is chopping necessary? How done?
11. Describe good methods of cultivation.
12. Discuss the damage from boll-weevil.
13. Give methods of controlling this pest.
14. Enumerate methods of securing an early crop.
15. Mention cotton diseases and give remedies.
16. Describe the harvesting of cotton and give local and other yields.
17. Describe the plans for ginning in your section or elsewhere.
18. Give uses of seeds.
19. What are the most common market grades of cotton?
20. What uses are made of business and private warehouses?
21. How is money secured by cotton farmers for financing their crops?

Farm Mechanics.—Make seed-treating revolving box or barrel; dusters; mop poisoners; sled harvester; truck box; wagon top-box. Repair dusters, planters, fertilizer distributors, cultivators. Paint old machines.

Calculations.—1. A cotton grower treated seed to remove the lint and produce uniform planting with tested seed. This cost, in acid and labor, 28¢ per acre. By so doing he saved 3 pecks of seed per acre when seed was 90¢ a bu. He also saved half the work of thinning which would otherwise cost $1.10 an acre. Find his net saving on 20 acres.

2. Many growers of a community decided to grow long-staple cotton instead of short-staple. Through extra effort and an additional average cost for seed and fertilizer of $2.10 per acre, the yields of lint equalled those of short-staple. There were 58 growers having an average of 26 acres each. What was the extra cost for long-staple cotton?

3. The 58 growers in problem 2 produced an average of 190 lb. of lint per acre. Find the total lb. of lint produced and the average per planter.

4. The growers in problems 2 and 3 received 2½¢ a lb. over the market price for short-staple cotton. Find the net profit per farm over the extra cost of $2.10 per acre.

5. A young cotton farmer borrowed money at 6 per cent per annum for financing his 15-acre cotton crop. His purchases were paid in cash. For fertilizer materials: 15 cwt. of superphosphate at $20 a ton; 15 cwt. kainit at $14 a ton. Poison for insects: Calcium arsenate 50 lb. at $18 per cwt. Find how much money he needed for all these materials and find the interest cost for an average of 5 mo.

6. A neighbor of the young grower in problem 5 with a cotton field of the same size bought 1½ tons of ready-mixed fertilizer, paying on time purchase $33 per ton. He purchased 50 lb. poison for which he was charged $13 on the store books. Find his outlay for these materials. How much more did his credit plan cost than the cash plan in problem 5?

TOBACCO ENTERPRISE

Analysis into Jobs.—The following teaching units include the main operations in the pursuit of a tobacco enterprise. References are to pages in *New Agriculture*, Davis' *Farm Projects and Problems* and to numbers of available *U. S. Farmers' Bulletins*. Get bulletins from your Station. See *Field-Crop Enterprises* and *Southern Field-Crop Enterprises*.

1. **Deciding whether or not to raise tobacco**, pp. 219, 220; *Farm Projects*, 240–241; *Bulletins*, 571, 1580. *Local inquiry*.—Get advice of local growers regarding this enterprise.
2. **Choosing the soil, field and acreage**, p. 219; *Farm Projects*, 241, 242; *Bulletins*, 571, 1475. *Local inquiry*.—Growers should be asked to discuss tobacco soils, rotations and areas.
3. **Growing cover crop and providing organic matter**, p. 219; *Farm Projects*, 242; *Bulletin*, 571. *Local inquiry*.—Ask growers to discuss importance of organic matter and how to secure it.
4. **Choosing type, variety and strain**, p. 220; *Farm Projects*, 241–242; *Bulletins*, 571, 1580. *Local inquiry*.—List the types and varieties and strains grown locally and ask experts to compare them.
5. **Procuring and treating seed**, p. 220; *Farm Projects*, 242; *Bulletins*, 428, 571. *Local inquiry*.—(*a*) To what extent are diseases considered by growers when choosing seed plants? (*b*) Compare seed treatment with freedom from disease.
6. **Selecting site for seed bed and treating it**, p. 221; *Farm Projects*, 243; *Bulletins*, 571, 1629. *Local inquiry*.—(*a*) Compare seed bed sites. (*b*) Describe local methods of treating beds.
7. **Starting and caring for seed bed**, pp. 220–222; *Farm Projects*, 243–244; *Bulletins*, 571, 1580. Investigate how this job is done locally.
8. **Preparing the field for planting**, p. 222; *Farm Projects*, 244–245, 246; *Bulletin*, 1250. *Local inquiry*.—Find the best local methods of preparing tobacco fields.
9. **Transplanting and fertilizing**, p. 222; *Farm Projects*, 244–245, 246; *Bulletin*, 571. *Local inquiry*.—(*a*) Describe machine and hand transplanting. (*b*) What fertilizing is done at planting time and what afterward?
10. **Cultivating the crop**, p. 222; *Farm Projects*, 245–246; *Bulletin*, 571. *Local inquiry*.—List cultivation tools and ask regarding depth of cultivation.
11. **Controlling enemies**, p. 223; *Farm Projects*, 246–247; *Bulletins*, 571, 660, 846, Beetles; 1494, 1531. *Local inquiry*.—List the worst diseases and insects and find how they are controlled.
12. **Topping and choosing seed plants**, p. 222; *Farm Projects*, 248; *Bulletin*, 571. *Local inquiry*.—Find what rules the best growers follow in this job.
13. **Suckering. Priming**, pp. 223, 224; *Farm Projects*, 248–249; *Bulletin*, 571. *Local inquiry*.—The time and conditions governing these operations should be learned from growers.
14. **Preparing the house and equipment for harvesting**, pp. 224, 225; *Farm Projects*, 249; *Bulletins*, 523, 571. *Local inquiry*.—Owners of new and old tobacco barns should be interviewed regarding this job.
15. **Harvesting and scaffolding**, p. 224; *Farm Projects*, 249; *Bulletins*, 523, 571. *Local inquiry*.—What plans for wilting the plants after cutting do you find? Study the methods and speed of cutting on different farms.

16. **Curing tobacco,** pp. 224, 225; *Farm Projects*, 250, 251; *Bulletin*, 523. *Local inquiry*.—Study local curing methods and ask farmers to compare them.
17. **Stripping, sorting into hands and bulking,** p. 225; *Farm Projects*, 251, 252. *Local inquiry*.—Get the best experts to describe the steps.
18. **Grading hands,** p. 225; *Farm Projects*, 252. *Local inquiry*.—The secret of grading should be studied with the help of the best graders.
19. **Marketing,** p. 226; *Farm Projects*, 252. *Local inquiry*.—Get opinion of growers regarding the best marketing methods.
20. **Keeping records,** pp. 18, 19; *Farm Projects*, 32-35, 77, 78; *Bulletins*, 511, 572, 782, 1182. *Local inquiry*.—Make forms for labor cost and other cost items. Get growers to give details.

Farm Mechanics.—Make propagating frames; hand planters; harvesting laths; knives; hauling frames. Repair bed-sterilizing devices; machine planter; curing barn; cultivators; sprayers; and dusters.

Calculations.—1. Two tobacco growers each had 10 acres and sold their products the same day. "A" sold 8,000 lb. low-grade tobacco at an average price of 4½¢. "B" sold 11,000 lb. high-grade tobacco at an average price of 10½¢. Find the total income of each, and the difference in income per acre due to quality or type.

2. By becoming an expert grader a young man sorted, graded and tied his 10,000 lb. of tobacco in three weeks. His neighbor had a like crop, for the grading of which he paid $105. How much a lb. did the first save by his knowledge?

3. Two growers have similar soils and types of tobacco. "B" fails to fight the "worms" so well as "A," and thereby saves $1 an acre for material and labor. When each sells his 8-acre crop "B" receives only 8¢ average per lb., while "A" has a higher average and receives 10¢. What was "B's" net loss? Consider the yield in both cases at 900 lb. per acre.

CHAPTER XV

TOBACCO ENTERPRISE

In value, tobacco holds eighth place in American field crops. The product is used by human beings because of the presence of nicotine, which is a narcotic alkaloid, having a quieting effect on the nerves. It is somewhat analogous to the opium poppy and the betel-nut of the palm family, used respectively for smoking and chewing. The three products are all sedative. Nicotine is most abundant in the leaves of tobacco. Those containing the highest percentage are considered the best. Largeness and fineness of leaf are desirable characteristics in the crop.

About one-third of the American crop is produced in North Carolina. Other tobacco-growing states in their usual order are Kentucky, Virginia, Tennessee, South Carolina, Georgia, Ohio, Pennsylvania, Wisconsin, Maryland, and Connecticut. This shows the range of the plant which is not restricted closely to any one latitude or climate. (Figs. 138 and 139.)

Soils.—A wide range of soils is used in growing the different types of tobacco. Some are sandy loams with very moderate amounts of fertility while others are heavy clay loams with a high degree of fertility. All, however, must have good drainage.

Rather loose, open-surface soils having good drainage but underlaid with heavy subsoils are most favorable conditions. The moisture is thus held fairly well, and a steady growth through the season results. The soils and climatic conditions of a region largely determine the type of tobacco which can be grown there.

Fertilizers for Tobacco.—" Tobacco is hard on the land " is a statement commonly heard among growers. Much fertilizer in available form is required for best results. Careful selection of fertilizer ingredients is necessary. Experience of other local growers should be studied. Some ingredients seem to be actually detrimental to some types of tobacco. Too much phosphate, for example, affects the ash of cigars. The potash is invariably in the form of sulfate, not muriate or kainit. Barnyard manure and green manure furnish the best forms of nitrogen and supply organic matter. Some growers, however, also use dried blood, tankage, cottonseed meal. Too much nitrate of soda is likely to prove detrimental.

Determining Types and Varieties.—It is usually very im-

portant that the growers of one section be united upon types and varieties as well as to methods of handling, curing, and marketing. Buyers coming to that region know what types of tobacco they will find. For a grower to produce a different type there would be fatal so far as marketing is concerned.

Three types of tobacco are cigar, export, and manufacturing. Cigar tobacco is of three types of leaf—filler, binder, and wrapper.

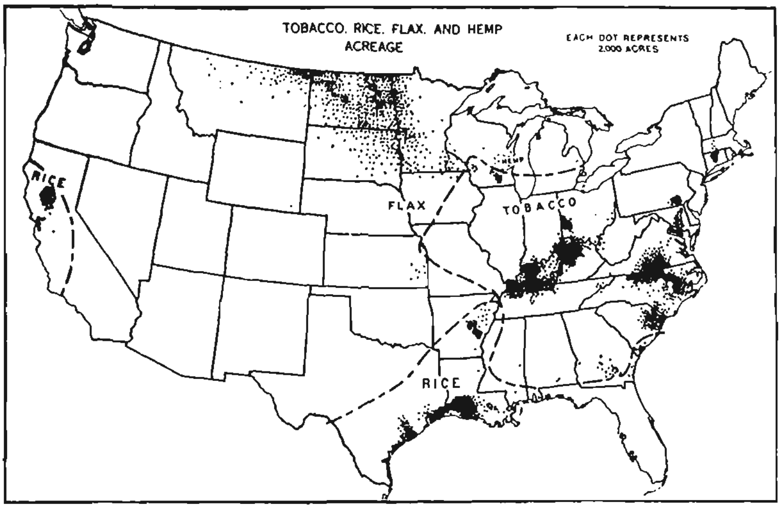


FIG. 138.—Distribution of tobacco, rice, flax, and hemp, each dot representing 2,000 acres. (U. S. D. A.)

To the export and manufacturing types belong the Virginia sun-cured, the dark fire-cured, flue-cured, and the light Burley.

Seed is usually secured from local patches. Certain healthy seed plants of desired type are left untopped to send up seed stalks. A few such plants in a field will produce an abundance of seeds for the next season. Flowers of seed plants should be covered with paper bags before pollination takes place, to prevent crossing with undesirable plants.

Preparing the Seed Bed.—Plants for seeding in fields are first started in seed beds two months or more in advance. The beds are usually protected by cloth or glass and in cold climates some heating by manure or pipes is necessary. To help avoid the damage from fungous diseases in the bed growers usually practise "burning the beds" before planting time. This consists in placing piles of wood and brush over the area and burning them. Diseases, weed seeds,

and insects are thus killed if the soil is thoroughly heated to a depth of several inches. Steam is successfully used in place of burning tobacco beds. The best spot for the seed bed is a southern exposure on virgin soil or where tobacco has not been grown. Pulverize the surface and make a fine seed bed after burning. Large

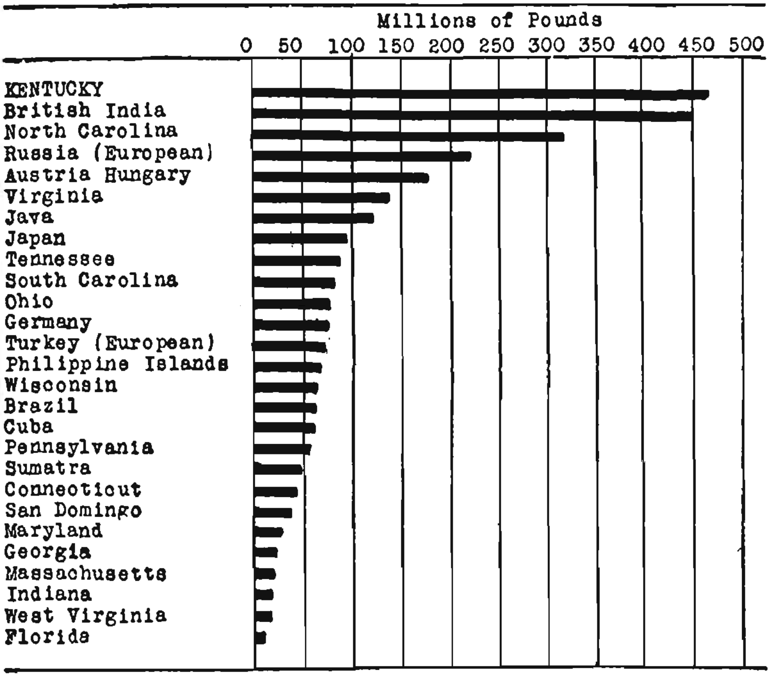


FIG. 139.—Tobacco production in the principal tobacco growing areas of the world. (Kentucky Station.)

fields require large seed beds. About 100 square feet of seed bed is ample for each acre of field. If conditions seem unfavorable twice this area may be allowed. The best plants should always be secured and some choice should be possible. Beds are usually three to six feet wide and of any length needed.

Tobacco seed should be cleaned to remove light and immature seeds. A teaspoonful of seed will sow fully 200 square feet of bed. As the seeds are extremely small they should be evenly mixed with dry wood ashes or sifted soil before sowing. A more even stand in the bed will result. Seeds are very lightly covered with a hand rake or by sprinkling the bed with water or by pressing with a

board or by the use of a light broom. Twelve-inch boards or poles are placed on edge around the bed, either before or after planting. These are usually supported by stakes driven in the ground. Muslin is stretched over these or glass is laid on. Ventilation to prevent damping off requires constant attention, particularly if glass is used. Some growers roll the muslin on long, straight poles and tack one edge to the upper side of the bed. This allows rolling the "canvas" off on warm days and replacing it easily at night.

Preparation of the Field.—If a cover crop has been grown the preceding fall and winter this should be plowed under a few weeks before seeding time and should be disked in well and the surface pulverized with a harrow. A few weeks of bare-fallow will greatly benefit the crop by sprouting and killing weed seeds, warming the soil and controlling moisture.

Setting the Plants.—Soon after the last spring frosts are over, when the soil is in good, warm condition, and weather suitable, the plants should be set in the field. This should not be done on hot or windy days. The plants are not hard to start in the field if reasonable conditions prevail at setting time. Different varieties require different distances between the plants. Space between rows varies from three to four feet and space between plants in rows eighteen to thirty-six inches.

In all intensive tobacco sections machine planters are commonly used. (Fig. 140.) This machine opens one row and marks the place for the next. The plants are placed by two boys or men on the rear. The plants are watered from the tank automatically and the soil is brought around the plants by two blades. Three acres a day are readily planted by such an outfit.

Various methods are followed in hand planting. Frequently a furrow is made with a horse and shovel plow. Plants are distributed along the furrow by boys and girls and men follow to complete the planting.

Culture.—In well-prepared fields, deep tillage **after setting** is seldom practised, unless the soil is very heavy. If deep tillage is necessary, this should be done by the first cultivation. After that shallow cultivation is usually practised. Continue cultivation until there is danger to the plants. The field should be thoroughly clean of weeds and grass when cultivation ceases.

Topping.—Skilful growers soon learn the proper time to cut or break the tops to prevent seed production. It is after the leaves have all formed and the top is ready to shoot up. All plants are thus topped except a few healthy, typical plants chosen to bear seed.

Suckering.—Suckers are formed in the axils or angles of leaves. These are removed when a few inches in length. This is a slow, tedious job as the plants must be examined several times. Failure in suckering greatly reduces leaf growth.

Insects.—The chief insect enemy of tobacco is the large tobacco worm, the larva of a sphynx moth, which flies at twilight and lays her eggs on the plants. A long spine at the caudal end of the larvæ gives it the name, hornworm. The use of powdered arsenate of lead at the rate of one to two pounds per acre will be very effective in protecting the leaves. This powder may be mixed with about twenty times its bulk of lime dust or finely sifted wood ashes, and applied with a bellows or other dusting device

FIG. 140.—A transplanting machine opens the furrow, waters the plants and presses soil about them. It is used for tobacco, cabbage, sweet potatoes and similar crops. (Kentucky Station.)

when the leaves are moist with dew. This should be done as soon as the smallest worms are discovered, as large ones are difficult to poison. Some hand picking of worms may be necessary even when poison is used.

Diseases.—Damping-off in the seed beds is chiefly controlled by burning the beds and by careful ventilation during the growth. However, heavy losses in the beds sometimes result when the weather is unfavorable.

Mosaic disease has been very destructive in some sections recently. Choosing seed plants immune to the disease seems to be the most effective means of control. Rotation of crops will undoubtedly help. The crop should never be grown where the disease has occurred within two years.

Priming.—The first step in harvesting is called priming. It is practised chiefly for cigar leaf tobacco. It consists in the removal of the most mature leaves about the base of the plants. As the leaves above these continue to mature they are harvested in order. By this method the grower is able to begin harvesting much earlier and continue it less intensively until completed. The leaves are gathered in small " hands " or bunches. These may be hung in

bunches or singly on racks for hauling to the curing barn. A little wilting of leaves in the field before hauling to the barn is desirable. However, over-exposure at this time must be avoided.

Harvesting the Whole Plants.—Most tobacco in this country is harvested by splitting the stalk from the top to within a few inches of the ground. Then the stalk is cut off near the ground and is placed on a lath or "stick," running the lath through the split. These laths, when loaded, are placed across racks made for hauling the tobacco and are taken to curing barn or scaffolds. (Fig. 141.) The tobacco should be allowed to wilt somewhat before being placed on laths and loaded on wagon as it bruises much more easily when the leaves are crisp.

Ripeness of tobacco is indicated by the feel of the leaves, by

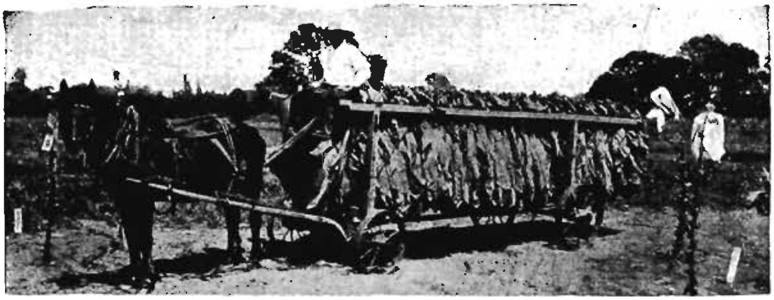


FIG. 141.—Rack for hauling tobacco from field to curing barn. Bagged seed plants may be seen standing in the field. (U. S. D. A.)

the brittleness of the veins when folded between the fingers, and by the slight yellowing of leaves. Frost in northern states often determine the time of harvesting, as the crop must be in before frost.

Curing.—There are three main types of curing tobacco which are: Air curing, open-fire curing, and flue curing. (Fig. 142.) Air curing is accomplished in specially constructed tobacco barns having ventilators up and down all sides. Open-fire or open-hearth curing is accomplished in barns without special ventilation and is used chiefly for dark type of tobacco. Flue curing is in barns similar to the last, but with more ventilation at the top, the circulation of air being caused by the heat. Flues conveying the hot smoke run through the barns.

Several weeks are required to complete the curing process, by any of the methods. Much study and experience is required to conduct the work successfully. All tobacco barns are provided with timbers and supports on which tobacco laths are placed.

Stripping.—When tobacco has been cured on the stalk the next step is stripping, which consists in removing the leaves from the stalks. This should be done on moist days in early winter when the leaves are in proper "case." If too dry they would be damaged by cracking and breaking. If they are becoming slightly too dry to "bulk" they are sometimes moistened a little, but it is better to have the leaves in natural condition with enough moisture present without adding any. They must be neither too wet nor too dry when in bulk.

Grading.—During the stripping and bulking of tobacco leaves

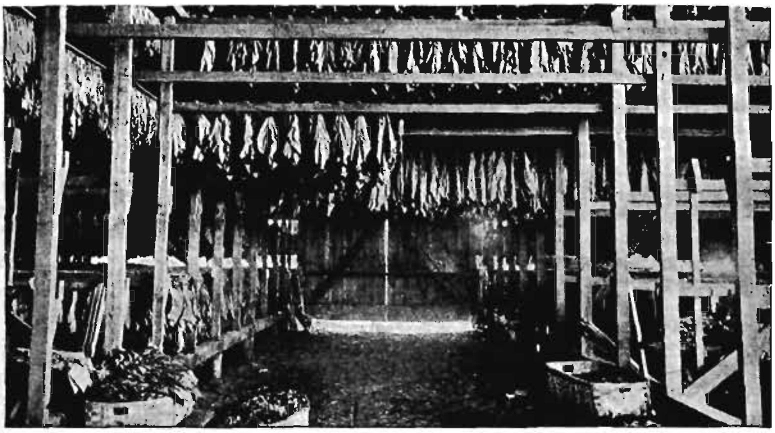


FIG. 142.—Interior structure of tobacco curing barn, with strings of tobacco being cured (U. S. D. A.)

they are sorted into three, four, or five grades, depending upon the type of tobacco. Leaves of any one grade are tied into small bundles and these into larger ones, according to the type of tobacco. When tobacco is packed and graded in cold weather it should be marketed then, or if held until spring should be hung out to dry as some sweating will take place. After this, it is ready to be put into large permanent bales or prized in large wooden hogsheads.

Marketing.—In tobacco-growing centres large warehouses are often found where sales are made. Much of the tobacco sold during the winter season on these floors is in the loose leaf condition. Tobacco which is to be shipped is prized into hogsheads, each containing one grade only. The kind of package for shipment depends upon the market requirements.

Yields.—Different types vary in yield from 600 to 1,500 pounds

of cured tobacco per acre. Broad-leafed tobacco, grown under shade, may yield a ton or more of cured tobacco per acre.

Prices.—Broad-leafed wrapper tobacco usually brings the highest price and growers of such tobacco are not likely to suffer from severe cuts in prices; but low grades are subject to the severest fluctuations in prices. Coöperative associations are formed by growers in some sections. In such cases prices are usually better and growers are better satisfied.

Surveys, Trips, Projects, and Exercises

1. **Surveys.**—In tobacco sections make a survey among the growers including such points as these: Areas in tobacco; sizes of beds; burning beds; seed; setting fields; fertilizers; number of cultivations; insect damage; diseases; type of barns; sizes; harvesting; losses in curing; time of stripping; yields; methods of selling; prices; cost of production.

2. **Field Trips.**—In tobacco sections visit beds and fields in spring; harvest fields and curing barns; warehouses and sale floors; visit factories, if possible.

3. **Projects.**—In tobacco sections students may plan projects in growing tobacco for profit. Three to five acres may be undertaken, if barns are already built. Let the project include all steps arranged somewhat as the headings in this chapter. Plan to employ some labor when necessary. The items of cost and employment should be carefully recorded.

4. **Trials with Projects.**—Compare tobacco fertilizers; grow part of the field with green manure and part without; set part of the field closer than the rest; compare Paris green with arsenate of lead in dusting for tobacco worms.

5. **Exercises.**—In the laboratory grow tobacco seeds at different depths of covering. Have different lots of tobacco leaves brought to the laboratory for practice in sorting and judging. From the soil collect pupæ or larvæ of hornworms and observe their transformations at least as far as the egg stage.

Questions and Investigations

1. Tell what you can of the importance of the tobacco crop in your county and state.
2. Which are the leading tobacco states?
3. Describe soils for light and for dark tobacco.
4. What fertlizers are good for tobacco?
5. What types and varieties are produced in your region or nearest you?
6. Describe the preparation and planting of a tobacco bed.
7. How are fields prepared before setting the plants?
8. Describe setting by hand and by machine.
9. What implements are used in field culture?
10. Give methods and purposes of topping. Of suckering.
11. Mention enemies and give their remedies.
12. Describe methods of harvesting tobacco.
13. Outline three methods of curing.
14. When and how is stripping done?
15. Give reasons and methods of grading.
16. Describe methods of marketing tobacco.
17. Tell of yields and prices you have known.

ORCHARD ENTERPRISE

Analysis into Jobs.—The following are the main teaching units, or operative and managerial jobs, in the orchard enterprise. The references are to pages in *New Agriculture*, Davis' *Horticulture Enterprises*, Sears' *Productive Orcharding*, and to numbers of available *U. S. Farmers' Bulletins*. See also *Southern Horticulture Enterprises*.

1. **Deciding whether or not to grow orchard fruit**, pp. 227, 253; *Horticulture*, 27, 109; *Sears*, 1–7; *Bulletins*, 727, 917, 1001. *Local inquiry.*—(*a*) Talk with orchard growers regarding yields, losses, expenses, costs for labor and materials. (*b*) Get opinions of orchardists as to the advisability of starting orchards.
2. **Studying nursery methods**, pp. 229–233; *Horticulture*, 28, 114–118; *Bulletins*, 157, 702, 1501, 1567. *Local inquiry.*—Get local opinions regarding the advisability of producing orchard trees at home.
3. **Choosing the kinds and varieties of fruit**, pp. 228, 229; *Horticulture*, 35, 118–121; *Sears*, 24–43; *Bulletin*, 918. *Local inquiry.*—(*a*) Find what varieties of summer, fall and winter apples are considered most valuable in home orchards; in commercial orchards. (*b*) What varieties of other orchard fruits are preferred locally?
4. **Choosing location, soil and site**, pp. 227, 228; *Horticulture*, 39, 121; *Sears*, 7–23; *Bulletins*, 1372, 1405. *Local inquiry.*—(*a*) Study local orchard sites and criticize or justify each. (*b*) Find the preferences regarding local soils for each of the types of orchard fruits.
5. **Preparing the orchard soil**, pp. 40–42, 233, 234; *Horticulture*, 40, 125–126; *Sears*, 44–46; *Bulletins*, 1250, 1591. *Local inquiry.*—(*a*) What forms of fertilizer are applied to orchard soils before planting? (*b*) Describe the best local methods of preparing an orchard area before planting.
6. **Laying out the site for planting**, pp. 234–235; *Horticulture*, 44, 127; *Sears*, 47–49; *Bulletin*, 917. *Local inquiry.*—(*a*) Study both young and old orchards to find the plan followed in planting. (*b*) Find arguments given by local farmers for and against the use of fillers.
7. **Buying trees and receiving shipment**, pp. 229, 237; *Horticulture*, 42, 123; *Bulletin*, 1591; *Sears*, 38–43. *Local inquiry.*—(*a*) Secure catalogues and prices from your state nurseries. (*b*) Calculate the cost per acre for trees of each of the orchard fruits. (*c*) Ask orchardists when they would order trees and where they would buy them. (*d*) Get their opinions on one-year-olds *versus* two-year-olds for apples and pears. (*e*) Get their opinions regarding June-bud peaches.
8. **Planting fruit trees**, pp. 236, 237; *Horticulture*, 47, 128; *Sears*, 49. *Local inquiry.*—(*a*) Ask a good orchardist to describe just how he plants a tree. (*b*) Ask how they get trees in line with or without a planting board. (*c*) Inquire regarding the best time for planting.
9. **Growing intercrops**, p. 239; *Horticulture*, 48, 128; *Sears*, 66–76. *Local inquiry.*—(*a*) What other crops are grown between rows of orchard trees in your region? (*b*) Compare these crops in suitability. (*c*) Find the objection of growers to those which are not suitable. (*d*) How many years do local orchardists grow intercrops among apples? Among peaches?

10. **Cultivating the orchard**, pp. 237, 238; *Horticulture*, 50, 129; *Sears*, 77–90; *Bulletins*, 917, 945, 1307, 1518. *Local inquiry.*—Compare the successes of orchards that are regularly cultivated with those that are not, and get opinions of growers regarding this.
11. **Fertilizing the orchard**, pp. 239, 240; *Horticulture*, 51, 132; *Sears*, 100–108. *Local inquiry.*—(*a*) Ask a number of growers to find how fertility of orchards is maintained. (*b*) What commercial fertilizers are applied and when? (*c*) Compare the time of applying for early fruits with the time for late fruits.
12. **Pruning the orchard**, p. 240; *Horticulture*, 54, 133; *Sears*, 120–141; *Bulletin*, 181. *Local inquiry.*—(*a*) Describe the pruning found in local young orchards. (*b*) In bearing orchards.
13. **Spraying against insects and diseases**, pp. 214–249; *Horticulture*, 60–91, 138–145; *Sears*, 144–157; *Bulletins*, 662; Weeds, 722, 938, Bitter-rot; 1120, 1128, 1270, 1285, 1380, 1397, 1478, 1479, 1527, 1557, 1666, 1676, 1687. Find the commonest spray programs used locally.
14. **Fighting borers**, pp. 243, 244; *Horticulture*, 67, 142–143; *Sears*, 155, 157, 160; *Bulletins*, 675, 763, 1065, 1557. *Local inquiry.*—(*a*) How do local growers control apple borers? (*b*) Peach borers? (*c*) Describe local cases of injury from borers. (*d*) In what month is chemical usually used for peach borers?
15. **Renovating old orchards**, *Horticulture*, 92; *Sears*, 212–228; *Bulletins*, 1284, 1369. *Local inquiry.*—(*a*) Locate old orchards that need renovating. (*b*) Try to decide what renovating measures should be used in each.
16. **Protecting against frost**, p. 241; *Horticulture*, 145; *Bulletin*, 1588. *Inquiry.*—(*a*) What proportion of the local crop of apples is injured by late frost? (*b*) Of peaches? (*c*) Of plums? (*d*) How do some growers protect against frost?
17. **Harvesting orchard fruits**, pp. 250, 251; *Horticulture*, 96, 147; *Sears*, 237, 238. *Local inquiry.*—(*a*) Describe the harvesting and handling of delicate orchard fruits—early apples, peaches, plums, pears and cherries. (*b*) Describe the harvesting and handling of late apples and pears. (*c*) Compare varieties of the same fruits regarding differences in handling.
18. **Storing fruit**, p. 251; *Horticulture*, 98, 99; *Sears*, 245; *Bulletins*, 1160, 1380. *Local inquiry.*—(*a*) Describe local ways of storing fruits. (*b*) Get the opinions of farmers regarding the value and methods of storing.
19. **Grading and packing fruit**, pp. 251, 252; *Horticulture*, 99–103, 150; *Sears*, 258–275; *Bulletins*, 1204, 1266, 1457, 1579, 1687. *Local inquiry.*—(*a*) Ask growers into what grades each of the local fruits is sorted. (*b*) Describe places best suited to grading and packing. (*c*) Ask orchardists their opinions regarding coöperative packing. (*d*) Find who inspects packing of fruits.
20. **Marketing and using fruit**, p. 251; *Horticulture*, 104, 151; *Sears*, 277; *Bulletins*, 900, 984, 1080, 1144, 1264, 1266, 1424, 1471, 1687. *Local inquiry.*—(*a*) Get opinions regarding coöperative selling. (*b*) Describe the best individual selling you can find. (*c*) Find the market outlets for local fruits and compare them. (*d*) List the local uses of all the fruits.
21. **Keeping financial accounts**, pp. 18, 19; *Horticulture*, 106, 107; *Bulletins*, 511, 572, 582, 1182. *Local inquiry.*—(*a*) Make forms for recording costs of planting, pruning, spraying, fertilizing, and harvesting. (*b*) Calculate the profits and losses for one orchard.

CHAPTER XVI

ORCHARD ENTERPRISE

THE term orchard is applied both to fruits and nuts. In this chapter the several fruits considered are apples, peaches, plums, pears, and citrus fruits. Brief treatment is made of the growing of pecans and English walnuts.

Regional Adaptations.—The great number of varieties of apples makes this crop more widely grown in different regions than any of the other orchard crops. Apples are grown for home use and commercial purposes in all parts of the United States and Canada.

The leading states in apple production are New York, Ohio, Washington, and Oregon.

Peaches are grown in northern states where lakes or seas modify the climate. Thus, Michigan is modified by the waters of Lake Michigan and is much used for peaches, while the west side of the lake is little used. Westerly winds do not cause the lake to modify the Wisconsin side. In the great plains region west of the Missouri River peaches are seldom grown commercially north of Kansas. In the Allegheny region high altitudes, not exceeding 1,800 feet above sea level, are used as they furnish excellent air drainage, which prevents injury from frosts at blossoming time. On the Atlantic slopes commercial orchards are found from Massachusetts and Connecticut to Florida. Georgia is by far the leading peach state of the South, although Tennessee and North Carolina are now making large shipments.

Plums being of different types are as widely distributed as apples. But the leading plum and prune sections are found in moderate or warm climates, such as the Pacific states, along the Great Lakes, the Atlantic seaboard and the southern states.

Pears have much the same distribution as apples but are less vigorous and therefore more limited where winters are severe.

Nut culture is chiefly restricted to the Gulf states and southern Pacific states. Pecans and black walnuts, of course, are grown inland farther than the others.

Soil Adaptations.—Apples and pears prefer medium and heavy soils while peaches thrive better on medium and light soils. Plums of the American type readily grow on good peach soils. Many of those of the European type prefer the medium soils,

which is also true of Japanese plums. The latter, however, thrive well on apple soils.

Soils for nut orchards should be particularly well drained and deep. The subsoils should be friable or gravelly to allow the penetration of tap roots. In general, medium and light soils give best results.

Choosing Sites for Orchards.—In all regions where spring frosts are likely to occur when the orchard is in blossom air drainage is of vital importance. Slopes allow cold, frosty air on such nights to glide down to the valleys. Breezes are produced and damage from frosts often avoided. Fires and smudges, when necessarily used at blossoming time, will more readily produce breezes in sloping orchards than in low, level places. Frosts seldom do damage to blossoms if winds are blowing or if clouds form. (Fig. 150.)

Citrus fruits are chiefly grown by irrigation in California. For convenience in irrigation the sites should be only slightly sloping. Level valleys or tablelands are secured where water can be allowed to flow gently from the upper toward the lower side and soak into the soil gradually.

It has long been claimed that northern and eastern slopes are better than southern or western slopes. The arguments are that (1) protection from westerly winds will prevent some breaking of trees and drying of soil during hot weather; (2) protection from southwesterly sun will cause less sun scald of the trunks in either summer or winter; (3) on north and east slopes sap from the roots and trunks will not start so early in the spring and blossoms may not form until after killing frosts are over. Many orchardists, however, disregard all these arguments, particularly in favorable regions, and pay little attention to exposure.

Choosing Varieties.—In deciding what varieties of fruits or nuts to grow in an orchard one should bear in mind the following principles: (1) Use fewer varieties in commercial orchards than in home orchards. (2) Do not try new varieties until they are proven successful in your soils and climate by experiment stations or trial orchards. (3) The best commercial varieties are those which bring the best price in that market to which your fruit must go, regardless of season of ripening. (4) Unless you are the first grower of fruit in your region you should profit by the experience of other growers who have tried varieties near you.

Apple varieties for the home orchard may consist of two each for summer, fall, and winter ripening. In the northeastern states these might be Duchess and Transparent for summer; Grimes'

Golden and Wealthy for fall: Baldwin and Delicious for winter. For commercial purposes the grower must consider earliness and regularity of bearing, life of trees, season of ripening, abundance of yield, immunity from diseases, as bitter-rot, cancer, cedar-rust and twig-blight, color, quality, size, endurance of handling and keeping.

Varieties of peaches depend more upon soil adaptation and climate than upon market preferences and other characteristics. Those popular in one market are likely to be so in others. Northern growers often find late varieties very profitable. If the crop is to go to a local market a wide range of ripening would be better than concentration of the crop in one season. The leading commercial varieties grown at Fort Valley, Georgia, in order of ripening, are Hiley, Belle of Georgia, and Elberta. Farther north a suggestive home orchard list would be Red Bird, Greensboro, Carman, Hiley, Belle of Georgia, Elberta, J. H. Hale, and Brackett. The New Jersey Experiment Station recommends the following varieties of peaches, *given in order of ripening*: Carman, Hiley, Champion, Belle of Georgia, Elberta, Fox Seedling, Edgemont Beauty, Iron Mountain, and Krummel October.

Securing trees is usually done in one of three ways: (1) Ordering from travelling agents is the poorest way; (2) ordering from reliable nurseries by catalogues; (3) growing your own trees. The second method is usually followed by commercial orchardists. Each nursery usually grows varieties that are most popular in its territory. After deciding upon your numbers and list place your order with the nursery as many months in advance of shipment as possible. State the diameter of tree one foot from the ground, the age and the number of each variety. Reliable nurseries do not make substitutions unless your order allows it, but many mistakes are made even in the best nurseries, particularly very large ones. If possible visit the nursery before ordering. See the quality of trees, methods of handling, freedom from scale and diseases, and become personally acquainted with the manager. Your order will receive better attention.

Growing Peach and Plum Trees.—Nurseries plant seed of peaches and plums in the fall, or early spring if stratified the fall before. Northern nurseries bud these young seedlings as they are growing in the rows in August or September. Southern nurseries bud in June, July, and August. The buds used in many cases are secured from healthy bearing trees of the varieties desired. For July, August, and September budding, twigs of the current

year's growth bearing healthy shoot buds, are cut in orchards and the buds inserted near the ground under the bark of the seedlings in nursery rows. For June budding, twigs are taken in the dor-

FIG. 143.—School boys budding peach seedlings with buds from good varieties (Illinois Normal University.)

mant stage, packed in moist sawdust and held in cold storage until needed. (Fig. 143.)

When the buds begin to grow, which is the following spring, or the same summer in case of June budding, the seedlings are pruned just above the points of budding. No seedling buds are allowed to live after that. June budded trees are sold cheaper than others because one year of growth in the nursery is saved.

Growing Apple and Pear Trees.—Seeds are gathered from cider mills in large quantities. Seedlings are grown in nursery rows one summer. During the dormant season these are dug, tied in bundles, and shipped to nurseries over the country as stocks for

budding and grafting. The chief states in the growth of such stocks are Iowa, Kansas, and Nebraska. Where stocks are raised they are often budded in the nursery rows as in the case of peaches.

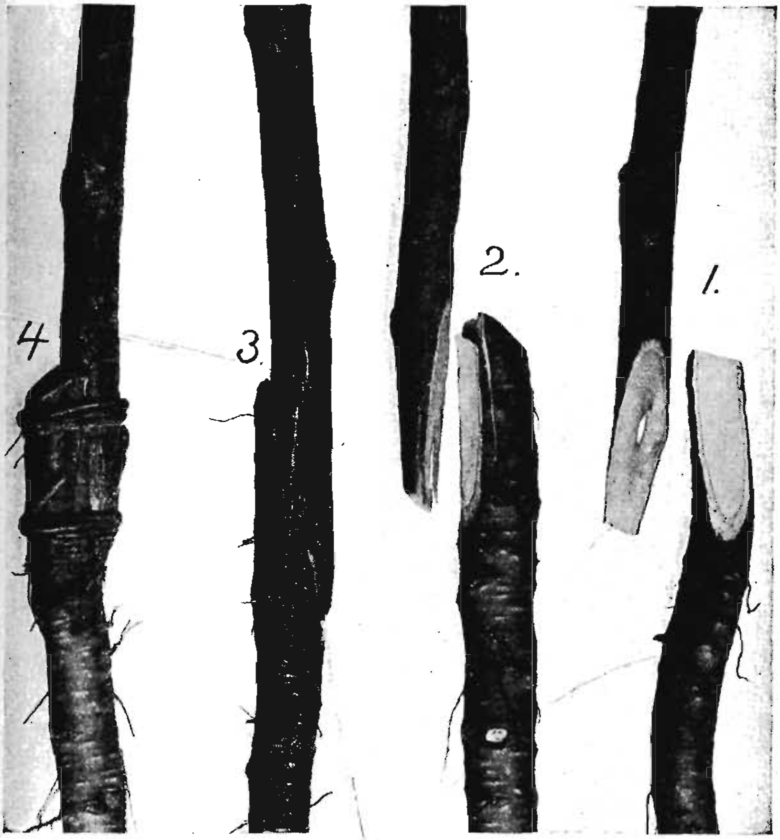


FIG. 144.—Steps in making apple root grafts by the whip or tongue-graft method, scions above, roots below. Waxed cotton (No. 18) is used to wrap and no knot is tied. (Minnesota Station.)

Many apples and pears are root grafted instead of budded. This work is done in cool rooms in the winter time. The tops of seedlings are entirely removed and twigs (called scions) from good varieties are grafted on the roots by the process known as tongue grafting or whip grafting. (Figs. 144 and 145.)

The roots are sometimes cut to pieces about four inches long, each piece being grafted to a scion. The root grafts are tied in

bunches, properly labeled, buried in moist sawdust and held in cool cellars, to be set in rows in the soil about corn-planting time. If allowed to grow in these rows one year they are called one-year-old trees. Two summers' growth makes them two-year-old trees; this being less common.

Trees such as apples and pears are sometimes cleft grafted in the tops to change the variety or for other purposes. (Fig. 146.) Not many growers practice cleft grafting.

Pecans and English walnuts are both propagated by top-budding and top-grafting. As the trees have tap roots the seedling stocks are often planted in the orchard rows and then top worked, different methods of grafting and budding being used by different

FIG. 145.—Laboratory practice in budding and grafting fruit trees.

growers for different varieties. English walnuts were often grown from seed without top working, but recently desirable varieties are budded on black walnut (*Juglans nigra*) in the western states, on *J. rupestris* in the southern states, and on *J. regia Californica* in the Pacific states.

Oranges, lemons and grape fruit are all propagated by budding as in the case of peaches. The stocks used are those most hardy and best suited to the soil and climates of their respective regions. Hardiness of stocks is most important in the Gulf region where the *trifoliate* orange is used for this purpose. Other stocks used for oranges are seedlings of sour orange, rough lemon, and grapefruit.

Age for Planting Trees.—Southern commercial orchardists plant June budded peaches. Otherwise peaches and plums are almost invariably yearlings when planted in orchards. This is true also of the citrus fruits. It should be true of apples and pears, but frequently two-year-old trees are used. The points in favor

of planting yearlings rather than two-year-old trees are given: (1) You get first choice from the nursery. (2) You can head back the trees to suit your plants. (3) They cost less. (4) They transplant more successfully. The argument advanced for planting two-year-old trees is that they may bear sooner after transplanting. This, however, is seldom true as the transplanting checks their growth more severely.

When to Plant.—Planting of trees may be either in the fall or spring when the trees are dormant. Fall planting allows the soil to become well settled and root hairs are likely to form earlier and

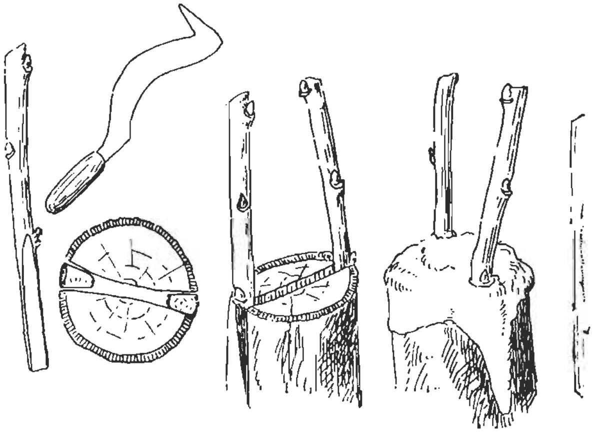


FIG. 146.—Cleft grafting. A limb is cut off even and split as with the cleaver shown. Scions are cut beveled both ways as shown at the left. Grafting wax is used to protect all the wounds.

start the growth in the spring better than spring planting. Fall planting, on the other hand, may allow puddling of soil about the roots in poorly drained places or in wet seasons; and if the winter be windy and dry, trees may suffer from evaporation about the trunks.

Preparation of the soil for orchards should be made well in advance and should be as thorough as for seed beds. If possible the field should be one where an orchard has not been growing and where there is also a good growth of green manure to turn under for the present orchard.

Deep plowing or subsoiling is often practised. The importance of these depend upon the character of subsoil. Light, open subsoils do not need stirring.

Terracing hillsides for orchards is one of the best plans by which orchards may be grown on steep slopes and yet be cultivated

regularly. Too often orchards are planted on hillsides and the surface is seeded to grasses to prevent washing. The orchardist should always plan to practise clean cultivation. This is most important while the trees are young. Planting on steep hillsides is economical of land and supplies necessary air drainage for the orchard. Terracing prevents washing and allows clean cultivation.

If the hillside be curved, run a horizontal line as a belt around the hill for the first row of trees. Run the rows of trees above and below this belt line at proper planting distances from the first. When plowing the orchard later throw the furrow slices toward the trees down the hill. Benches or terraces will soon be formed.

Plans of planting are of three main types: (1) The trees are planted in squares. (2) The trees are sometimes planted in hexagonal form, sometimes called triangular planting. (3) The tree rows on hillsides may follow contours or terraces.

Distances for planting.	Feet apart each way.
Apples, standard	25 to 40
Apples and pears, dwarf	10
Pears, standard	16 to 20
Cherries, standard	18 to 20
Cherries, Dukes and Morrellos	16 to 18
Plums	16 to 20
Peaches, Apricots, Nectarines	16 to 18
Quinces	10 to 12

Use of Fillers.—As orchard trees usually require several years between planting time and bearing age, the soil between the trees, to be economically used, is planted to some useful crop. One way of using it is to grow other orchard trees called "fillers" which will bear younger than the others, and which are to be removed after the standard, permanent trees are large enough to require the space.

Fillers in apple orchards consist of other apple trees which bear much younger and are to be sacrificed later. For example, in an orchard planted to York Imperial or Northwestern Greening, Missouri Pippin or Wealthy could be set half-way between.

Frequently peaches and sometimes plums are used as fillers in apple orchards.

As pecan trees are set forty to sixty feet apart in orchards, peaches, plums, grapes or other crops are used for a few years.

Laying Out the Orchard.—A straight line along one side or near it should be staked. At right angles to this, locate another line at or near the corner of the orchard. (Fig. 147.) On these lines drive a stake for each tree at distances desired. Then with two poles, each equal to the distances between trees, one or two

persons can rapidly locate stakes for the next row of trees each way. As many rows may be thus located in advance of digging as desired.

If the triangular method of planting is to be followed, one base line with a stake for each tree is first established; then two poles, each equal to the distances between trees, are used to locate a row parallel to this first row. Suppose the first two trees be *A* and *B*. Place one end of one pole at *A* and one end of the other pole at *B*, then bring the other two ends together at a point called *C*; this locates the first tree in the second row. Continue to locate other

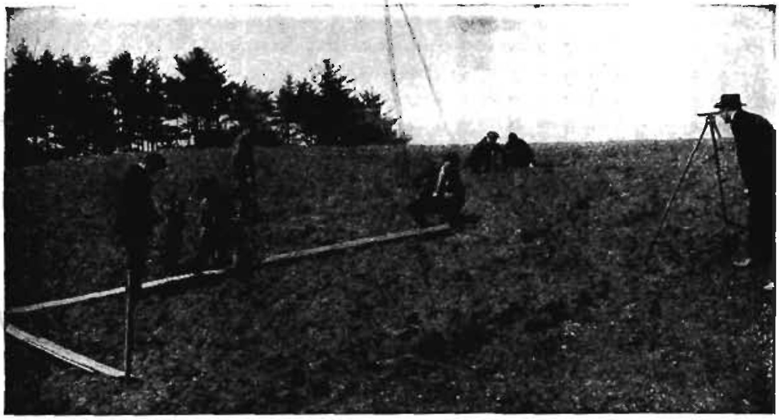


FIG. 147.—When the first two lines of stakes are established forming a right angle, the others may be easily located. (H. N. Loomis.)

trees in like manner. This plan is slightly more economical of space than the first.

Distances between Trees.—Apples are usually planted at distances varying from thirty to forty feet, depending on the richness of soil, the spreading habit of the variety and the system of pruning to be followed. Peaches, plums and pears are usually planted at about half the distances for apples. English walnuts are often set thirty by sixty feet, while pecans vary from forty to sixty feet. Distances for citrus fruits differ greatly in different sections from fifteen to twenty feet.

When trees arrive from the nursery they should be immediately unpacked and "heeled in." Make a trench with one sloping side and put the bunches of trees with the roots in the trench, with the tops lying out over the sloping side. In this leaning position cover the roots with plenty of soil. Beginners lose many trees by exposure before planting.

Using a Planting Board.—As stakes are usually placed where

trees are to be planted it is readily seen that when the stake is removed to dig the hole the location will be lost unless a planting board is used. Figure 148 shows the structure and use of such a board. The notch is placed over the tree stake and the two end stakes are located. These remain in place until the hole is dug and the tree planted. The board will fix the location of the tree exactly.

Preparing holes for trees is an important job. Make the holes

FIG. 148.—A planting board fixes the location of the tree after the hole is dug. (Florida Station.)

much larger and deeper than apparently necessary to receive the roots. Loosen the soil somewhat about the sides and in the bottom, and replace some of the richest surface soil. Prepare the holes before trees are taken to the orchard so that the trees may have their roots covered quickly.

Pruning Roots.—When trees are taken from the trench to be planted the roots should be examined and trimmed with a sharp pruning knife. Remove any injured or broken roots. Watch for root-gall and discard any trees showing it. Extra long roots may be pruned a little. Some prefer to prune the tops before planting. (Fig. 149.)

Planting trees should be carefully managed so that roots will not be exposed long to wind and sun. Orchardists often dip the

roots of each bunch of trees in mud of a creamy consistency to protect them during planting. When the tree is in its proper place the crown should be just a little lower than the surface of the soil. Throw about the roots the best soil first and as soon as the roots are covered a little, tramp very firmly so that capillary moisture will be drawn to the roots and no air spaces will be left about them. Then finish filling the hole. The top surface should be left loose to prevent evaporation.

Pruning after Planting.—Just after the trees are planted is the best time to prune them. The height left at this pruning will determine the length of the main trunk of the future tree.

FIG. 149.—Trees are often pruned before they are set in the orchard (New Jersey Station.)

Low Heading vs. High Heading.—Orchardists differ in the practices of heading the trees high or low. (Fig. 150.) This matter must be decided when the tree is first pruned. The points in favor of low heading are given: (1) Top pruning is easier; (2) thorough spraying is more easily accomplished; (3) harvesting the fruit is more rapid and less laborious; (4) limbs are less likely to be broken by the weight of fruit and by harvesting; (5) less propping is necessary; (6) more trees per acre may be grown.

The points in favor of the old high heading plan are these: (1) Cultivation near the trees is easier; (2) there is less danger to the limbs during cultivation; (3) more air circulates about the trees, possibly avoiding some disease.

Clean Culture vs. Sod in Orchards.—Systematic tillage of orchards results in several benefits: (1) Causes the roots to feed deep; (2) conserves soil moisture and checks damage from drouth; (3) makes plant food more available to the trees; (4) the fruit is larger and more abundant; (5) diseases and insects are more easily controlled; (6) allows the use of leguminous cover crops which supply nitrogen; (7) damage from mice and rabbits is less.

The claims for maintaining a permanent sod in the orchard are given: (1) Less labor and expense; (2) fruit sometimes more highly colored; (3) suits low heading better; (4) less washing on slopes not terraced; (5) wind-fall fruits are less damaged; (6)

spring spraying and pruning may be easier than when winter cover crops are not grown.

The New York Station found the following comparisons in a trial with true sod culture and clean tillage:

Sod.		*Tillage.*
434	Fruits per barrel	309
2.8	Barrels per tree	4.2
$71.52	Net profit per acre	$110.93
1.1	Gain in tree diameter	2.1

FIG. 150.—California low-headed apricot orchard, showing one orchard heater at each intersection of aisles. A double row of heaters is placed along the outside on the windward side. (California Station.)

Annual Tillage Plan.—When orchards are on terraced hillsides or on slopes where washing during the summer is only slight they should be cultivated systematically: (1) The soil should be plowed each spring to turn under a cover crop. This may be done after the blossoming season or it may be delayed until the spring sprayings are past. (Fig. 151.) (2) Harrow the surface just after plowing and repeat this about every two or three weeks or soon after every heavy, packing rain to maintain a loose surface and conserve moisture, or to allow surplus moisture to penetrate the subsoil. (Fig. 152.) (3) In mid-summer or soon after, sow a

cover crop to remain through the winter and be used as green manure the following spring. In cold climates rye and winter vetch may be sown the latter part of July or early August. Farther south rye and crimson clover may be used. Omit the legumes from the seeding if the nitrogen supply in the soil is likely to become too great.

Intercropping Young Orchards.—To make good use of the wide spaces between young trees many orchardists grow crops between the trees during the first few summers. The crops used should be (1) such as require clean cultivation; (2) profitable

FIG. 151.—Young Satsuma orange trees banked before plowing the orchard, to protect against frost. (Florida Station.)

crops; (3) annual crops which may be removed in time for planting winter cover crops; (4) crops which do not rob the trees of the elements they require; (5) crops which make their main growth after the early spring growth of the trees.

Among the crops which fairly well fulfil these conditions are lima beans, bush beans, and pole beans, cowpeas, soybeans, cucumbers, squash, melons, early-maturing Irish potatoes planted early in May. Avoid using perennial crops and any that are subject to the same diseases as sometimes affect fruit trees. Raspberries, for example, have root-galls produced by the same nematodes that attack peach trees. Strawberries take the same nourishment from the soil as the trees require and greatly retard the growth of the trees. Nursery stock, grain and hay should not be grown in orchards.

Fertilizing Orchards.—When trees are young they need more nitrogen than after they are of bearing age. If good green manure crops are plowed under each year enough nitrogen would be thus

supplied, but if soils be very poor commercial fertilizers should be supplied. The best time to spread these would be just after plowing the soil each spring or early summer. Harrow in the fertilizer immediately. Bearing trees need to be well supplied with both phosphoric acid and potash. Commercial nitrogen is seldom needed in bearing orchards where green manure crops are annually turned under.

Pruning Young Orchards.—Reference has already been made to the matter of heading to the height desired just before or after setting. Follow this the same summer by removing with the thumb any sprouts that would tend to form undesirable branches. Each winter or early spring prune with hand shears or sharp knives, keeping these principles in mind: (1) The shoots which are to form the main branches of the future tree should be at different heights on the trunk to avoid splitting when heavily loaded with fruit; (2) these branches should extend toward the different points of the compass; (3) the number should be from three to five; (4) the main shaft of the tree must not be allowed to form other branches which will overshadow the main ones you have selected.

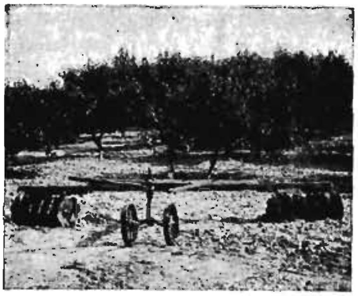


FIG. 152.—A disk harrow with extension bar and truck makes it easy to cultivate under trees that are headed low. (New Jersey Station.)

*In doing this pruning always cut close (Fig. 153) to the trunk or branch, never leaving a stub. Such stubs will die for want of leaf surface. A dead stub is "like a thorn in the flesh." It must decay and causes disease of the tissue. When cut close the under bark will burl over the wound and protect it from the weather. All large wounds should be painted with good oil paint of some kind.

Pruning Bearing Trees.—To understand how to properly prune a fruit tree one must know how the fruit is borne by that kind of tree. Apples are borne on spurs which form fruit buds. (Fig. 154.) This is true of pears and some types of plums. Other types of plums and all peaches are borne on the youngest twigs. Several points should be remembered in pruning bearing trees: (1) Remove all diseased parts; (2) all broken or injured branches; (3) allow sunlight to enter the top; (4) remove limbs that tend to cross the head of the tree; (5) when two or more shoots are parallel remove all but one; (6) cut back new growths enough to

cause the tree to remain within desired heights; (7) new growth on the sides should be cut back enough to cause branching and keep the tree within bounds.

Frost injury when trees are in blossom is one of the serious losses in some localities. Two methods of prevention are shown in figures 150 and 151.

Orchard Insects.—There are many kinds of insects attacking fruit trees and nut trees and their products. Several of the most important of these are considered in this chapter. Reference is made for more thorough studies of these to special volumes on insects, mentioned at the end of the chapter.

Codling moth attacks the core fruits, apple, pear, and quince, but is sometimes found in others. The pupæ are formed under rubbish and in crevices of the tree trunks. From these the adults emerge in early spring and lay their eggs in the blossoms about the end of the blossom period. The larvæ hatch from these eggs, eat their way into the young fruit, which forms immediately after the petals fall. They become about one-fourth of an inch in length and feed chiefly around the core, causing the fruits to decay and rendering them unsalable. Many of the fruits attacked by these larvæ fall to the ground in June causing what is known as "June drop." When fully fed the larvæ crawl from the fruits, form the pupæ stage and a second brood of moths is soon laying eggs on the fruit not already affected.

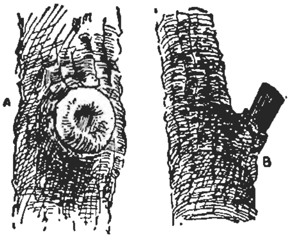


FIG. 153.—A, pruned close so that the bark can heal the wounds. B, not pruned close enough; the wound can never heal, but decay will follow.

Control of codling moth usually consists of poisoning the larva in the calyx before it enters the fruit. (Fig. 155.) Spray just after the petals fall, with arsenate of lead, 1½ pounds of powder in fifty gallons of water, or in weak lime-sulfur solution. If the paste forms of poison be used, double the strength. This spray should be *repeated twice about* two weeks apart.

Canker worms eat the leaves of apples and some other kinds of trees. Thorough spraying with poisons while fighting codling worms will largely control them. An extra spraying before the blossoms open will be necessary when attacks are serious. As the adult females have no wings, they may be prevented from laying eggs on the foliage by banding the tree trunks with sticky fly-paper. This must be done before attacks are made.

Tent Caterpillars.—Large webs are frequently seen on apple trees, cherry trees and others. These are usually caused by tent caterpillars. Clusters of well-protected eggs may be seen on twigs during winter. The larvæ hatch in early spring and form webs as their home or center of action. They feed on the foliage and when fully grown transform through the pupal stage into moths which lay the next batch of eggs.

Control measures may consist of three steps: (1) Prune off egg masses in the winter; (2) prune away and destroy small tents as soon as discovered or burn them; (3) spray the foliage with arsenical poisons such as arsenate of lead or Paris green.

Apple Borers.—The worst of these is the flat-headed apple tree borer which is the larva of a beautiful bronze *Buprestid* beetle. The larva lives in apple, pear and quince trees for about two years feeding chiefly on sapwood. Its girdling injures or may kill the trees. The round-headed borer

is the larva of a long-horned beetle, which lives in the trunks about three years and burrows both in the sap-wood and the heart-wood.

The chief remedy is to dig out and kill the larvæ before they have done much damage. Use a sharp-pointed knife or a stiff wire. Orchardists sometimes wrap the trunks with heavy brown paper or tar paper to keep the adults from laying their eggs there. At the bottom this protection should be covered with soil and at the top it is tied closely just below the main branches. Repellant washes are of little use.

The plum curculio attacks all stone fruits, peach, plum, cherry. *A close relative attacks apples and other core fruits but is less serious.* The adults live over winter under rubbish and emerge in the spring, visiting the trees as the buds begin to swell or burst in search of their first

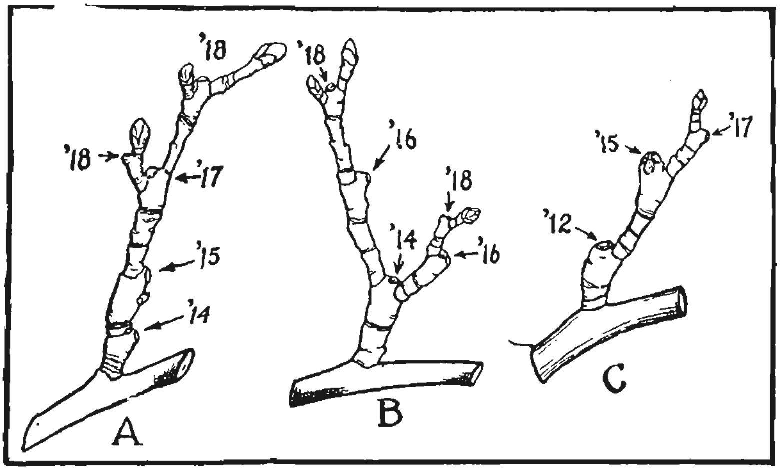


FIG. 154.—These fruit spurs are quite typical of Wealthy apple. They usually blossom every other year (B) although they may blossom in succession (A). Unless cared for they "run out" when older and cease to blossom at all (C). (Wisconsin Station.)

spring food. After feeding a little and mating, the females lay eggs on *young fruits when about the size of garden peas.* The **larvæ, when hatched,** enter the fruit at a point where the mother has punctured the skin in the form of a crescent. They feed within the fruit causing decay near the pit, rendering the product unsalable. Many of the attacked fruits fall to the ground when about half grown. When fully fed the larvæ emerge and transform through the pupal stage to beetles, known as snout beetles, having jaws at the end of a long protuberance of the head. They belong to the great family of weevils which attack beans, stored grains, and cotton.

Control consists in a spraying campaign to poison the adults and larvæ before the fruits are attacked. This is given later. Poultry and swine running in the home orchard will aid materially in checking the increase.

The San José scale is a very destructive insect attacking all fruit *and nut trees.* The citrus scale and some other forms attack citrus orchards. All scale insects obtain their nourishment by sucking juices from the tissues of the plants. They secrete coverings over their bodies which greatly protect them from the weather and natural enemies. They all multiply extremely fast and unless thoroughly and regularly destroyed on orchard trees they will become so numerous as to kill the trees.

Control of San José scale on deciduous trees is accomplished by

thorough spraying. In the winter lime-sulfur or miscible oil is used. When attacks are extremely severe miscible oil is used early in the winter and lime-sulfur in late winter or early spring.

Citrus scale insects are more difficult to control than San José scale because citrus trees are evergreen. Fumigation methods are very commonly employed in California as more thorough work can be done than by spraying. In Florida spraying with miscible oil and whale-oil soap is practised. In California large canvas tents, thoroughly air tight, are spread over the trees by use of derricks. These are often mounted on auto trucks, which move from tree to tree to place and remove the tents. The fumes are of hydrocyanic acid gas, produced under each tent by using a dish of

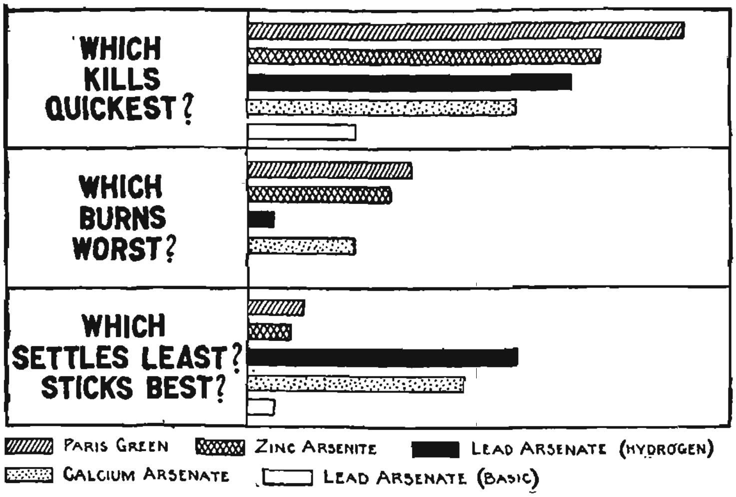


FIG. 155.—Use the best insecticide. The best spray is the one which burns the least, sticks best, and at the same time kills as quickly as possible. It is not necessarily the spray that kills quickest that is the best to use. (Wisconsin Station.)

potassium cyanide, on which is poured sulfuric acid. Experienced men are employed for this work.

Peach tree borers attack trees of all the stone fruits. The adults are true moths, having the appearance of large wasps. These lay their eggs on the bark near the surface of the ground late in summer. One female, laying several hundred eggs, may infest many trees. The young larvæ feed on the inner bark and soft wood, channelling up and down or around the trunk. When fully grown they are nearly an inch long, slightly yellowish in color, with brown heads. These form pupæ the next summer before emerging as adults. The California peach borer attacks the trunks and limbs some distance above the soil.

Control methods consist of digging them out each fall and spring, using a sharp knife or wire. Recent experiments have developed another remedy applicable to trees about five years of age or more. Para-dichloro-benzene at the rate of about one ounce per tree is used to destroy the borers beneath the surface of the soil. Use it in the fall after all eggs have probably hatched and before the soil temperature falls below sixty degrees F. Remove the litter and some soil from around each tree with a hoe, sprinkle the powder in a two-inch band on the bare soil some two inches or more from the trunk. (Fig. 156.) Cover this with a few inches of soil,

tamping it with the back of the shovel. This chemical evaporates and the fumes destroy most of the borers without injuring the trees. The cost per tree is less than the laborious method of digging out the larvæ.

Banding trees as described for apple borers is often practised to prevent the adult moths from laying their eggs on the trunks.

Diseases of Orchards.—As only a few of the most serious diseases can be considered here, reference is made at the end of the chapter to horticultural books treating diseases more fully.

Apple scab seriously affects all the core fruits. The crop formed in the orchard may be almost totally destroyed by this fungous disease. (Fig. 157.) The leaves, small twigs, and young fruits are *all* affected. The

Fig. 156.—Steps in treating peach borers with para-di-chloro-benzene. Left, litter and gum removed from surface; centre, one ounce of the chemical placed in a narrow band two inches from tree; right, soil free from litter packed with shovel around tree, to a depth of three to six inches. (New Jersey Station.)

scabby appearance of the fruit gives origin to the name. The disease lives over winter in the form of spores scattered in rubbish about the orchard.

Control is successfully accomplished by spraying. The winter spray for scale will kill many of the spores. Another spray of lime-sulfur is made when the buds are beginning to open and before the blossoms appear. Lime-sulfur or Bordeaux should be mixed with each of the sprays used in the control of codling moth.

Apple rust attacks the leaves, twigs, *young* fruits of apple, pear, and quince. Each alternate generation of the fungus lives on the cedar tree in the form of orange masses called "cedar apple." (Fig. 158.) If cedar trees are not grown near orchards this disease gives no trouble. Spraying for scab will largely control rust unless the cedar trees near by are badly infested.

Blotch fungus forms blotches on the leaves which give origin to this name. The same spraying campaign used against scab will control this disease fairly well, but should be repeated twice more.

Brown-rot on stone fruits causes the familiar rot just before or about ripening time. (Fig. 159.) Early varieties are more susceptible and some varieties are fairly immune. Mummied fruits cling on trees over

winter, from which spores are scattered the next season. Twigs are often badly blighted by this fungus. Winter spraying with lime-sulfur for scale will kill many spores of brown-rot. If lime-sulfur be used with the poisons in the campaign against curculio, this disease will be fairly well controlled. It may be necessary with some varieties to continue the spraying to within a month of ripening date.

Peach scab is a serious disease of stone fruits in some sections. Fruits are caused to harden and split on one side and twigs turn brown. Sprayings used for brown-rot should effectually control scab.

Peach Yellows.—This is a constitutional disease, no organism being found to cause it. Any one or all of these symptoms may be found on affected trees: (1) Premature and uneven ripening of fruit. (2) Bitter and insipid taste. (3) Dense clusters of stiff, narrow leaves, particularly from terminal buds, often yellowish in color. (4) Stiff-leaved, yellowish shoots from the body of the tree. (5) Spotted character of the fruit and its flesh. (6) Small, slender growth of all new wood. (7) Death in a few years. The best remedy is to eradicate trees and roots and burn them when discovered. Do not confuse yellows with *rosettes*, or little-peach diseases; nor with results of borers; nor with starvation of trees.

Fig. 157.—Scab disease on apple.

Annual spraying campaign for apples and other core fruits will usually consist of the following steps (Fig. 160): Spray in the dormant stage with lime-sulfur of the winter strength (1 to 7) to control scale insects and spores of fungi. Winter strength tests 5° on a Baumé hydrometer.

(2) Use lime-sulfur (summer strength, 1° B., 1½ gal. to 50 gal.), or Bordeaux, and lead arsenate (1½ lb. powder to 50 gal.) when the buds are swelling or opening and before the blossoms are opened (called pink spray), to control scab, rust, rot, and canker worm, bud worm and plant lice.

(3) Immediately after the petals fall, spray with same materials for codling moth, scab and other fungous diseases.

(4) Repeat this spray in about ten days or two weeks for the same purposes.

(5) Again repeat in two weeks, particularly if bitter rot or if blotch has been serious in the orchard the preceding year. For fighting bitter rot, Bordeaux mixture (4-5-50) should be substituted for the lime-sulfur, but the poison may be continued at the same rate to fight biting insects at the same time.

Spraying Campaign for Stone Fruits.—(1) A dormant spray

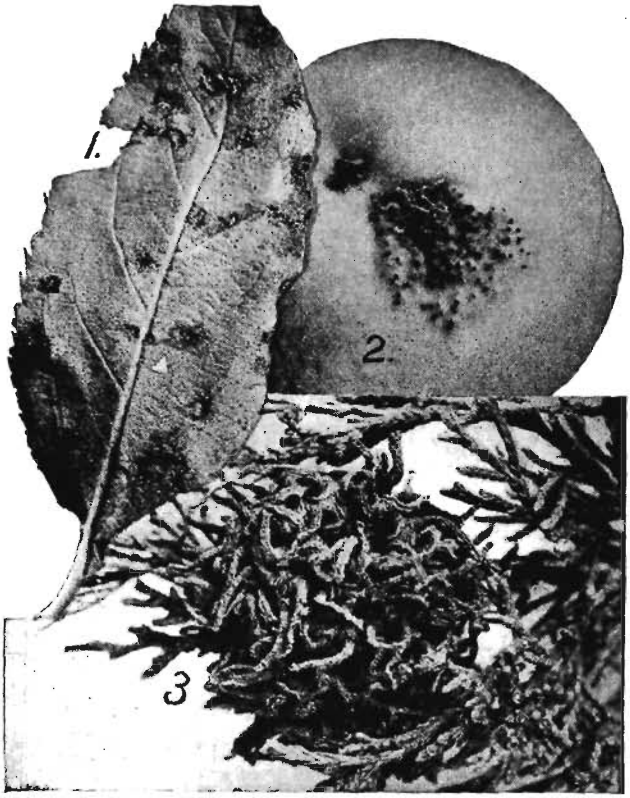


FIG. 158.—1. Apple rust on under side of leaf; 2. Same on fruit; 3. Cedar apple, the alternate generation of apple rust. (Illinois Station.)

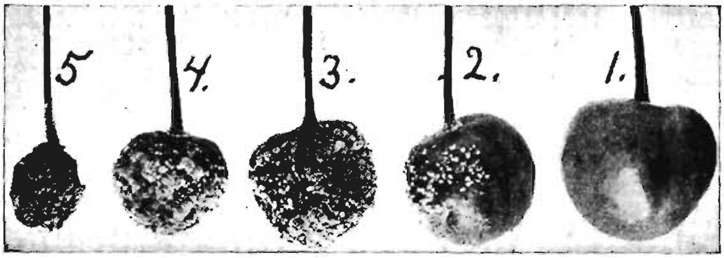


FIG. 159.—Brown rot disease on cherries, showing five stages of development. (Illinois Station.)

with lime-sulfur, winter strength (1 gallon to 7 gallons water) against scale and spores of fungi. This is done just after the winter pruning is over.

(2) Use self-boiled lime-sulfur, 8-8-50 (8 pounds fresh lime, 8 pounds sulfur, 50 gallons water), with one pound of powdered

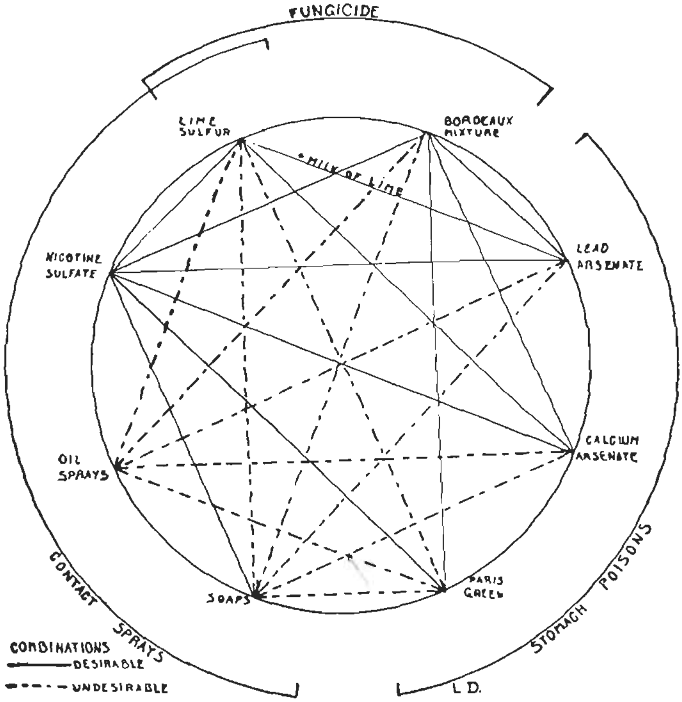


Fig. 160.—In spraying, two materials are often mixed together so as to accomplish two purposes at once. This diagram, adapted from the Massachusetts Station, shows the desirable combinations connected by solid lines. Undesirable combinations are shown by broken lines. (After Massachusetts Station.)

arsenate of lead, when buds first show a little color but are not open, to kill curculio beetles and disease spores. In the North or where curculios are less serious, poison may be omitted this time.

(3) Repeat the same spray at the time the petals fall to kill the main brood of curculio and control diseases.

(4) Repeat, using the same materials (poison omitted in South), about two weeks later when the stamen rings are just dropping from the little green fruits.

Where brown rot is very serious, similar sprays (without the poison) may be repeated to within a month before ripening for

each variety. In the South spray for a second brood of curculio about two months after the petals fall, using the same materials mentioned.

Spray Outfits.—For a small home orchard a barrel sprayer (Fig. 161) with a good pump, one 25-foot lead of hose, an 8-foot spray rod, and a good, angled, disk nozzle may be readily mounted on a cart or wagon and will give very satisfactory results.

For commercial orchards larger pumps and tanks should be used. Power sprayers (Fig. 162) give more satisfactory results than hand pumps or air pressure tanks. Two lines of hose from the pump will materially hasten the work as the rows on both sides may be sprayed at one time. Dusting is more rapid than spraying, but more material is used. (Fig. 163.)

Fig. 161.—Using a barrel sprayer in a farm wagon. (Missouri Station.)

Injury by Livestock, Rabbits, and Mice.—Orchards should be protected from livestock. It is not a suitable place to pasture sheep, cattle, or horses; swine and poultry at suitable seasons may be beneficial in controlling insects.

Rabbits do much damage to apple and pear orchards, particularly when the trees are young. Repellant washes are of little effect. Winter cover crops will aid greatly in supplying food which rabbits prefer, but when snows cover the ground rabbits are apt to do serious damage. They should be trapped or shot to prevent serious loss.

Mice burrow about the trunks of trees, gnawing the roots and bark. Rubbish about the trees furnishes them hiding places and increases the damage. Where no such litter is found no damage will result. Do the cleaning up before winter comes on. Go through the orchard a few times with a good dog and encourage him to examine all tree trunks.

Propping or wiring fruit trees when loaded with fruit is to keep the limbs from breaking down with their loads. Figure 164 shows the California plan of placing an iron ring in the center of the head and wiring the heavy limbs to this. Wire must not be

Fig. 162.—Gas engine spray outfit at work with high pressure to form a fine mist. (Michigan Station.)

Fig. 163.—Dusting apple trees against sucking insects. The New York station found that the work could be done as well when trees are dry as when wet with dew. Dusting saves time and labor, but the cost of material is greater than for spraying. The work must be done when the air is still. (Geneva, N. Y., Station.)

placed around the limbs, but a screw eye in each will serve the purpose.

Harvesting Fruit.—Nuts are often shaken to the ground and picked up immediately before discoloration takes place, but fruit should never be so shaken. Picking from the trees by hand is the

FIG. 164.—Bracing fruit trees by means of wiring instead of props. The ring is in the center of the tree head. Each wire is neatly fastened to the ring and to a screw eye in the limb to be supported. (California Station.)

best known method. Citrus fruits should never be gathered from the ground because of toxic properties which they soon acquire from the soil. All fruits of temperate climates are badly bruised when shaken and should be handled with great care. Rigid baskets hung from the left arm or from the ladder are better than bags, even for apples. In large commercial orchards apples are often picked in bags hung from the shoulders. Peaches and plums should be handled as little as possible. The picking baskets should be used to convey them to the packing shed.

Packing.—Apples are usually sorted into standard grades just

before marketing. (Fig. 165.) With summer and fall varieties, which do not keep well, this work is usually done at a point convenient to the orchard. Winter varieties which are to be held until markets are better, are usually held in storehouses, cellars or cold-storage plants, the grading being done at market time.

Peaches and plums often grow so uniformly on the trees in the

FIG. 165.- Interior of western apple packing house, where fruit is washed to remove spray material, graded, wrapped, and packed in bushel boxes. (U. S. D. A.)

orchards that little grading is necessary. This is done as the fruits are transferred from the picking baskets to the market packages, *i.e.*, crates, Delaware baskets, etc. (Figs. 166 and 167.)

Sizing or weighing machines are sometimes used for sorting apples and citrus fruits into three or four sizes. They are less frequently used for peaches and plums.

Standard grades of fruit have been established by the U. S. Bureau of Agricultural Economics. State laws often define the sizes of containers. Penalties are provided for misbranding varieties and grades. Commission houses and wholesalers are thus able to handle large quantities of fruit without opening the containers.

Selling Fruit.—In many sections coöperative associations do

the sorting, packing, and selling of fruit for the members. Each grower is paid for the amount of fruit of each grade delivered, at the best price that the association is able to secure. The manager

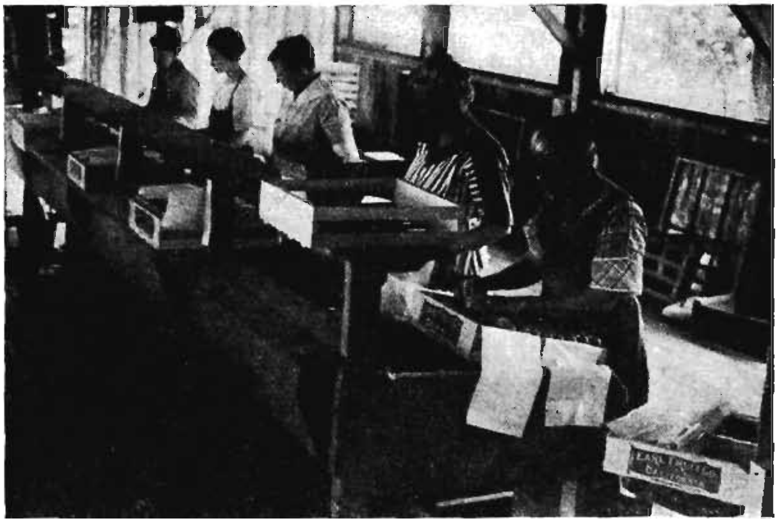


FIG. 166.—Interior of fruit packing house, showing arrangement of packing tables. There is plenty of light and ventilation. (California Station.)

watches markets closely and avoids selling in over-stocked markets. A demand is soon created for fruits bearing the association brand.

Growers often sell in large markets to commission men, to

FIG. 167.—The best grades of peaches are commonly marketed in small baskets crated as shown, called "Georgia carriers." Less fancy fruit is marketed in peach baskets shown on the right. (New Jersey Station.)

wholesalers, or direct to retailers. In many sections much of the fruit is marketed in local markets. These may be nearby or within short shipping distance. Mining towns, oil fields, and small cities often consume much of the fruit of the humid regions.

By-products are made from orchard fruits, by drying, canning, making juices and preserves. (Fig. 168.)

Optional Studies.—Study such topics as these: History of apple improvements. Developments of orcharding in America. Propagation of pears and quinces. Introduction of peach growing in America. Types of plums, American, European, and Japanese.

Further studies should be made of cherries. See references at close of this chapter for further studies in fruits of deciduous trees, citrus fruits, and nuts.

Surveys, Trips, Exercises, Projects, and Problems

1. **Field trips** should be made by students to study various operations in orchards such as planting, pruning, spraying, cultivation, fertilizing, sowing cover crops, picking, packing, and marketing. Students should take part in as many of these operations as necessary to become somewhat skilful in them.

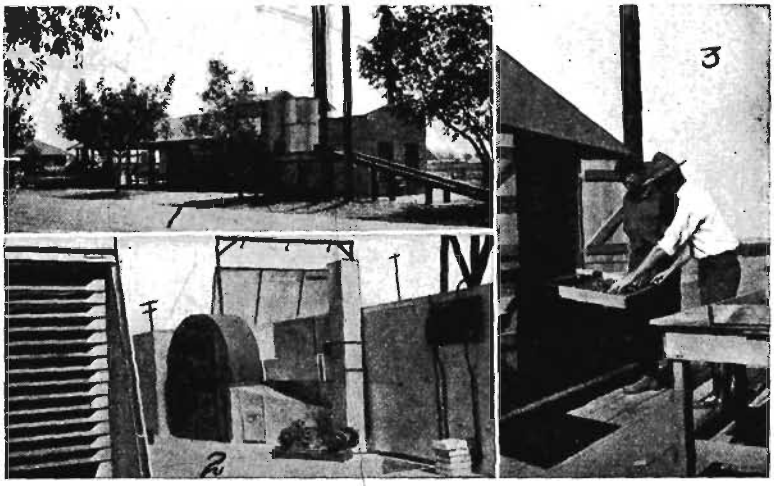


FIG. 168.—Three types of modern dehydraters used in drying apples, prunes, grapes and other fruits. (California Station.)

2. **Orchard Surveys.**—Include in local orchard surveys such points as these: Area; number of trees per acre; soil; fertilizer; cover crops; exposure; frost damage; heading of trees; pruning; culture methods; insect enemies; diseases; other enemies; spraying campaign; varieties; times of harvesting; picking; grading; containers; marketing; storage; yields; annual expenses.

3. **Problems Based on Survey.**—Calculate average yields for each kind of fruit included in the survey. Get each grower's percentage of the maximum yield. Determine maximum, minimum and average costs for annual maintenance. Compare spraying costs of each grower and determine his percentage of the most successful. Calculate profits from each orchard, and determine percentage of each grower with the one making the highest profit.

4. **Orchard Charts.**—Local varieties arranged by seasons of ripening; points to observe in pruning; formulas and rules for home-mixing of orchard fertilizers; annual spraying campaign; annual list of orchard

operations; list of enemies and remedy for each; cost account of annual operations; yields of a series of farms and their average.

5. **Orchard Pictures.**—Make and collect photographs of operations in orchards. From implement catalogues select orchard machinery. Pictures of fruits may be obtained from nursery catalogues, lithograph companies and various publications.

6. **Debates.**—"Clean culture *vs.* sod culture." "Terracing *vs.* sod for hill-sides." "Winter varieties *vs.* summer varieties of apples." "Pruning and spraying *vs.* no pruning and no spraying for home orchards." "Resolved that rejuvenation of old home orchards by modern methods is better than planting young orchards." "Local markets *vs.* shipment to distant cities."

7. **Orchard Projects.**—In order that a student may have project experience in all phases of orcharding, he may plan a project in two main parts: (1) Start a young orchard, operating it during the first year. (2) At the same time manage a bearing orchard through the year. A good orchard project for a student is to take a run-down, home orchard and rejuvenate it, managing it for one or more years until satisfactory yields are secured. The size of an orchard project depends upon the phases of work undertaken. A number of acres may be included in the project if it is already of bearing age and plans have already been in operation. A project in rejuvenating an old orchard involves so many difficult problems and so much labor that it may be smaller than other projects.

FIG. 169.—Laboratory exercise in judging fruit.

8. **Trials with Projects.**—Include valuable trials or demonstrations such as these: Compare one plan of management with another. Compare one spraying campaign with another. Compare the profits from one variety with those from another. Make fertilizer trials. Compare clean culture with sod culture. Compare slight pruning with heavy pruning.

9. **Exercises.**—In the laboratory, fruits should be assembled on plates for judging exercises. (Fig. 169.) Variety descriptions should be made on blanks for that purpose. Compete in variety identification. Collect and identify specimens of injury by insects and diseases. Practise making root grafts to be planted in the garden or nursery. Practise budding of peach, nut trees and others. Collect orchard insects and preserve them in pinning boxes. Make spray mixtures such as lime-sulfur and Bordeaux mixture. Test lime-sulfur with hydrometer for strength and test Bordeaux mixture for sufficiency of lime.

Spraying Program for Apples.

When	What to Use	What for
Winter	Lime-sulfur 5 deg. B.	San José scale.
Pink bud, just before opening	Lime-sulfur, 1 deg. B. 40% nicotine, ½ lb. to 50 gal. Arsenate of lead 1 lb. to 50 gal.	Scab, black rot, aphis, curculio.
When petals fall	Same, but omit nicotine	Scab, codling moth.
2 weeks later	Bordeaux mixture, 3–4–50; Arsenate lead 1 lb. to 50	Scab, blotch, codling moth.

If blotch or bitter rot are likely to occur, repeat the last spray about every two or three weeks until nearly picking time.

Spraying Program for Stone Fruits.

When	What to Use	What for
Winter	Lime-sulfur, 5 deg. B. (Add blue-stone for leaf curl)	San José scale.
1 week after petals fall	Lime-sulfur, 1 deg. B. Arsenate of lead, 1 lb. to 50 gal.	Curculio brown rot scab.
2 weeks later	Same	Same.
2 to 3 weeks later	Lime-sulfur, 1 deg. B.	Brown rot, scab.
3 weeks before late ripenings	Same	Same.

Questions and Investigations

1. What are the leading peach-growing states? Apple-growing?
2. What orchard fruits are grown in your section?
3. Give soil adaptation of apples, pears, peaches and plums.
4. Describe good orchard sites.
5. Give principles involved in choosing varieties of apples; of peaches.
6. Give methods of securing trees.
7. Describe the propagation of peaches and plums. Of apples and pears.
8. Give arguments in favor of one-year-old apple trees.
9. Give steps in thorough preparation of orchard soils.
10. Tell of the importance of terracing hill-sides for orchards. How?
11. Give your opinions regarding use of fillers in orchards.
12. Compare it with intercropping.
13. Give directions for laying out the orchard.
14. Describe heeling in.
15. Tell how to make a planting board. Give use.
16. Describe the preparation of holes.
17. Tell how to plant a tree correctly.
18. Describe root pruning; top pruning after planting.
19. Give arguments for low heading; for high heading.
20. Debate clean cultivation *vs.* sod culture.
21. Outline the annual tillage of an orchard.
22. Mention good crops to grow in young orchards.
23. What fertilizers would you use in a young orchard? In a bearing orchard?

24. Give directions for annual pruning of young orchards.
25. The same for bearing trees: Apple, peach, plum.
26. Give the life history of codling moth and directions for its control.
27. Give control methods for tent caterpillars. For apple borers.
28. Give the life history of plum curculio and methods of control.
29. Describe the damage from San José scale and give control.
30. Tell how to fight peach borers in young and old trees.
31. Describe apple scab and how to prevent it.
32. Tell of the relation of apple rust to cedar rust, and give control.
33. Describe frog-eye and its control.
34. Tell of the damage to stone fruits by brown-rot disease and give remedy.
35. Give symptoms of peach yellows, and remedy.
36. Describe the annual spraying campaign for apples.
37. The same for stone fruits.
38. Describe some good spray outfits which you have used or seen. What size would you prefer?
39. Suggest methods of preventing injury by livestock, rabbits and mice.
40. Describe harvesting fruit which you have seen and discuss the good and bad points.
41. Describe the packing of fruits in crates and boxes.
42. Tell of the need of standard grades of fruit.
43. Give suggestions for selling fruit.

Farm Mechanics.—Make picking ladders to suit your orchard trees; sorting table; packing boxes; hooks to support baskets on ladder; long-handled pickers. Repair disk harrows; cultivators; pruners; sprayers.

Calculations.—1. A man orders 1,000 apple trees. How many acres of land must he prepare for planting them if they are to be set 40 ft. apart each way? How many if planted 30 ft. apart? Allow 43,560 sq. ft. per acre.

2. This man finds by planting the trees 30 ft. apart in triangular form he can use about 16 more trees per acre. How many acres will this plan require? Draw a figure to show this plan.

3. By grading closely and selling only choice fruit in his markets a manager of a marketing association maintained a price averaging the growers $1.10 a bu. There are 32 members each averaging 12,000 bu. picked, and 30 per cent culled out. The operation of the association cost the members 2 per cent of the money received. Find the number of bu. sold by each grower. Find the net money returns to each.

4. In problem 3 find the number of bu. culled out by each and the total for all.

5. If the culled apples were used for cider and yielded 2½ gal. per bu., and this was sold at 27¢ a gal., find the income for culls for each orchard and for all combined.

SMALL FRUIT ENTERPRISE

Analysis into Jobs.—The following teaching units include the main operative and managerial jobs involved in any small fruit enterprise. The fruits included under this head are strawberries, grapes, raspberries, blackberries, currants and gooseberries. The references are to pages in *New Agriculture*, Davis' *Horticulture Enterprises*, Sears' *Productive Small Fruits*, and to *U. S. Farmers' Bulletins*.

1. **Deciding whether or not to grow small fruits**, pp. 257, 263, 266, 268; *Bulletins*, 727, 1001, 1242, 1522. *Local inquiry.*—(*a*) Get local growers to give their advice regarding the growing of the different small fruits. (*b*) Find whether these enterprises have increased or decreased recently and why.
2. **Choosing the kind and variety of fruit**, pp. 258, 259, 263, 266, 268; *Horticulture*, 157–161, 180–182, 209–213; *Sears*, 65–77, 232, 279–291; *Bulletins*, 887, 998, 1043, 1398, 1399, 1400, 1402, 1403. *Local inquiry.*—(*a*) Find why some of the small fruits are more popular than others in your region. (*b*) Obtain the names and opinions of all varieties of the small fruits grown locally.
3. **Propagating the plants**, pp. 259, 263, 266, 269; *Horticulture*, 182, 213; *Sears*, 72, 233, 236; *Bulletins*, 157, 471, 1567. *Local inquiry.*—(*a*) How many local growers propagate their own plants for small fruit crops? (*b*) What methods are used for each? (*c*) Ask growers regarding advantages found in propagating their own plants.
4. **Buying stocks and receiving shipment**, pp. 259, 264; *Sears*, 72–77. *Local inquiry.*—(*a*) Obtain lists and prices from nurseries in your state. (*b*) Ask growers from what sources they buy plants for these crops. (*c*) What diseases have been introduced through nursery stock?
5. **Choosing location, soil and site**, pp. 257, 263, 266, 268; *Horticulture*, 161–162, 185–186, 216; *Sears*, 1–8, 32, 161, 228, 273–275; *Bulletin*, 940. *Local inquiry.*—(*a*) Ask growers what crop should precede each of these crops. (*b*) Find the locations with respect to slope for the plantations in your region. (*c*) What type of local soil seems to be preferred for strawberries? For grapes? For others?
6. **Preparing the soil**, pp. 40–42, 50, 51, 257; *Horticulture*, 163; *Sears*, 32–37, 57–64, 159–162, 227–231, 275–278; *Bulletins*, 1250, 1606. *Local inquiry.*—(*a*) For which of these crops is barnyard manure used by local growers? (*b*) What growers turn under a green manure crop before planting?
7. **Planting**, pp. 259–261, 264, 266, 269; *Horticulture*, 164–167, 187, 217; *Bulletin*, 1591; *Sears*, 78–93, 163–172, 237–241, 292–300. *Local inquiry.*—(*a*) Find what systems of planting are in use for strawberries. (*b*) Calculate the number of plants required per acre for the distances used locally in planting each of the small fruits.
8. **Cultivating**, pp. 212, 213, 264, 270; *Horticulture*, 167–170, 188–190, 218; *Sears*, 8–20, 173–176, 262–265, 301–307; *Bulletins*, 887, 1026, 1027, 1028, 1307, 1401. *Local inquiry.*—(*a*) What types of cultivation are used for each of these small fruits? (*b*) How and when is each of these fruits cultivated?

9. **Fertilizing,** pp. 27, 44, 45, 69, 70, 270; *Horticulture*, 163, 168, 190; *Sears*, 20–26, 177–181, 245–246, 307–309. *Local inquiry.*—(*a*) How many of the growers use commercial fertilizers? Barnyard manure? Green manure? (*b*) What fertilizer ingredients do growers prefer? (*c*) Ask growers why they do or do not mix fertilizers themselves.

10. **Pruning,** pp. 261, 264, 267, 270; *Horticulture*, 168, 190, 219–224; *Sears*, 182–191, 254–255, 310–317; *Bulletins*, 181, 471. *Local inquiry.*—(*a*) To what extent do strawberry growers cut runners in the bearing patch? (*b*) Ask growers to describe the pruning of grapes and see how many systems you discover. (*c*) What canes are commonly cut away each year from the bush fruits—blackberries, raspberries, currants, and gooseberries?

11. **Training and staking,** pp. 264, 268; *Horticulture*, 191, 223; *Sears*, 192–201, 248–254, 317–335; *Bulletin* 471. *Local inquiry.*—(*a*) Ask growers why they stake or train or otherwise support certain bush fruits. (*b*) Find the methods followed. (*c*) Study local methods of trellising and training grapes.

12. **Protecting in winter,** pp. 260, 261, 265, 321; *Horticulture*, 169–170, 189; *Sears*, 125–134; *Bulletin* 1028. *Local inquiry.*—(*a*) Get strawberry growers to give their opinions regarding the time of applying and removing mulch. (*b*) What materials are commonly used for mulching strawberries? (*c*) Ask growers to tell what benefits result from mulching. (*d*) What special methods are used for winter protection of bush fruits and grapes?

13. **Fighting enemies,** pp. 261, 265, 267, 270, 272; *Horticulture*, 170–172, 195–201, 224–229; *Sears*, 39–45, 116–124, 202–208, 257–264, 310, 226–345; *Bulletins*, 835, 1028, 1286, 1345, 1398, 1458, 1488, 1676, 1687. *Local inquiry.*—(*a*) Find what are the worst enemies of each of the small fruits grown in your region. (*b*) Describe spraying and dusting machinery used in your region.

14. **Renovating an old plantation,** p. 263; *Horticulture*, 172; *Sears*, 136–143; *Bulletin* 1028. *Local inquiry.*—(*a*) What methods of renovating old strawberry patches do you find locally? (*b*) What bad practices can you find which tend to let small fruit plantations degenerate?

15. **Harvesting, grading, and packing,** pp. 262, 265, 267, 271; *Horticulture*, 173–175, 201–203, 229–230; *Sears* 209–216, 346–353; *Bulletins*, 1402, 1471, 1579. *Local inquiry.*—(*a*) Ask growers how they determine time for picking grapes; blackberries; other small fruits. (*b*) Into what grades are these fruits usually sorted before marketing?

16. **Marketing and using,** pp. 265, 272, 273; *Horticulture*, 175, 203, 231; *Sears*, 46–56; *Bulletins*, 1471, 1558, 1560. *Local inquiry.*—(*a*) Describe the best example of good marketing of small fruits in your region. (*b*) Talk to growers regarding improvement of marketing methods. (*c*) Make a list of all the uses you can find for each of the small fruits grown locally.

17. **Keeping records,** pp. 18, 19; *Sears*, 143; *Bulletins*, 511, 572, 782, 1182. *Local inquiry.*—(*a*) Make suitable blanks for keeping records for each of the small fruits of your region. (*b*) Ask growers to fill blanks.

CHAPTER XVII

SMALL FRUIT ENTERPRISE

STRAWBERRIES, grapes and the bush fruits such as raspberries, blackberries, currants and gooseberries are often spoken of as small fruits. Cranberries and blueberries, while not treated in this book, are also considered as small fruits.

STRAWBERRIES

The strawberry is not restricted to any one part of the United States. It is well distributed in all humid sections and is grown in irrigated districts also.

Soils.—Light, sandy loams or medium loams suit this crop best. An abundance of plant food produces largest yields. Heavy soils may be made suitable for strawberry growing by the use of green manure and heavy applications of barnyard manure. The use of lime on heavy soils after plowing under much organic matter will aid in flocculating the soil and making it more porous.

If fertilizers are used judiciously the crop will respond to heavy applications, but barnyard manure and green manure give better results than commercial fertilizers.

Locating the Plantation.—A sunny exposure best suits the strawberry. Have the site handy to the residence where the picking will be attended to regularly, and marauders are less likely to venture.

Preparation of Soil.—If possible, select a field which has not been occupied with an old grass sod during the last year. Sods are beneficial to strawberries, but old sods are likely to be infested with grub-worms. In the fall before spring planting sow a cover crop of rye and some winter legumes to be turned under in early spring. Disk the ground after spring plowing. Harrow crosswise of the disking and mark off the rows ready for planting. Bedding up the rows is seldom practised commercially. On poorly drained places slight bedding is allowable.

If planting is to be done in August or September as practised by many commercial growers, a good plan is to have the strawberries follow an early crop of Irish potatoes where clean cultivation has been practised. This will avoid much weed trouble later. If a heavy sod is turned under for the potato crop, it will be well rotted before the strawberries are set. Small grain is not a good crop for strawberries to follow because of danger of dry weather

If grain be followed, plow immediately after harvest, turning under some barnyard manure if possible. Disk or harrow the field a few times through a period of three or more weeks; if possible, before planting strawberries. This will conserve moisture, germinate weed seeds and destroy weeds and make plant food available for the strawberry plants.

Selecting Strawberry Varieties.—Inquire of neighbors and markets to determine what varieties are best to grow. Each region prefers its own varieties. Your state station can advise you. Strawberry blossoms may be of two kinds: (1) Pistillate and (2)

FIG. 170.—Strawberry blossoms on the left have stamens and pistils and are called "perfect." Those on the right have no stamens, and must be grown near a perfect variety to produce fruit. (New Jersey Station.)

perfect. Varieties having only pistillate blossoms will not bear fruit, unless some perfect flowered plants blooming at the same dates are near them. Varieties having perfect blossoms, with both stamens and pistils, can pollinate themselves and bear fruit without the proximity of other varieties and may *furnish pollen to pistillate* or imperfect varieties. (Fig. 170.) Examples of pistillate types are Black Beauty, Granger, and Sherman.

Popular varieties used in nearly all parts of the country are arranged by groups in order of ripening: (1) Excelsior and Dunlap. (2) Missionary, Klondike, and Blakemore. (3) Aroma, Premier, and Gandy. The Indiana Station recommends the following:

Earliest	*Medium*	*Late*
Gill	Senator Dunlap	Gray's Dollar
Excelsior	Haverland	Black Beauty
August Luther	First Quality	Columbia
	Grand Marie	Chesapeake
Early	Aroma	Sample
		Latest
Texas		Gandy
Klondike		Ohmer

Securing Plants.—Strawberries naturally propagate themselves by runners. Those setting next to the parent plant are called primaries; others secondaries, etc. In taking plants from an old setting the strongest and most vigorous plants should be selected.

Fig. 171.—Strawberry plants should be cared for promptly when received. Below, ready to be heeled in. Above, unpruned, pruned, and single plant of Dunlap variety. (Kentucky Station.)

Those with thick crowns will produce much more growth the first year than those having only one bud at the crown. When plants are purchased care is necessary to get the best. (Fig. 171.)

Plans for Setting Strawberries.—There are three main plans for setting and growing the field: (1) The matted-row system is by far the most common. The plants are set about eighteen inches apart in rows about four feet apart. The runners are allowed to

set plants in all directions freely for the first year, all the space between the rows being cultivated. Many growers plan to hold a space of about two feet for continuous cultivation, while others allow the whole area to become densely matted.

(2) The hedge-row system is becoming more popular. (Fig. 172.) The plants are set about eighteen inches apart in rows which are thirty inches or three feet apart. Each plant is allowed to form about two new plants and in the row only. All other runners are cut off by use of a scuffle hoe or wheel cutter. The entire space

Fig. 172.—The hedge-row system of growing strawberries, with straw mulch left between the rows during the harvest season. (New Jersey Station.)

between rows is left clear for cultivation throughout the life of the patch except when a straw mulch is used.

(3) The hill system is used mostly for gardens or small patches. The plants are set in rows each way about two feet or thirty inches apart. Cultivation may be carried on between the rows each way. The runners are not allowed to multiply. A modification of this plan is to set the plants about one foot apart each way and leave wide aisles every fifth row.

Hedge-row vs. Matted Row.—The several advantages of the hedge-row system are given: (1) Plants are not crowded and each develops a large crown. (2) The strength of the plant is used to produce berries instead of runners. (3) The plan allows the use of a straw mulch better than the matted plan. (Fig. 173.) (4) The straw mulch may be left between the rows; the berries lie upon it and are kept clean; the mulch close to the plants conserves

the moisture; keeps down weeds; and makes a clean place for the pickers. (5) After the picking is over the vines and mulch may all be removed to destroy insects and diseases. (6) Clean cultivation of the entire space between rows for the balance of the summer will stimulate production of strong crowns for next year's crop. (7) The berries are larger and more uniform in size.

The chief disadvantages of the hedge-row system are given: (1) More plants are required to set an acre. (2) Extra labor is needed

FIG. 173.—Strawberry field mulched for winter. (Kentucky Station.)

in cutting runners. This is balanced by less hand weeding. (3) Less neglect is allowable.

Disadvantages of the matted-row system are that it requires so much pulling of weeds and grass by hand if the patch is to be kept reasonably clean. Diseases and insects are likely to become much more severe. The berries may be as abundant, but are usually smaller and more variable in size, requiring extra labor in grading and packing. Pickers injure many plants and some fruit. Berries are more apt to become soiled or filled with grit during heavy rains. Drouths affect the crops worse. Picking is slower and more berries are missed.

Enemies.—The chief insect enemy is the strawberry weevil. (Fig. 174.) It is a minute black beetle which eats the flower stems causing them to droop. It is difficult to control. Dusting with arsenate of lead

powder mixed with twenty parts of lime dust or sulfur is often practised. Because of the danger to people using the berries, such dusting should not take place after picking begins. Do it when weevils first begin their work of cutting off the blossom stems. One of the best remedies is to mow the patch after picking and burn the vines. The new growth following is usually free from the pest.

White grubs are often serious in patches grown in matted-rows as

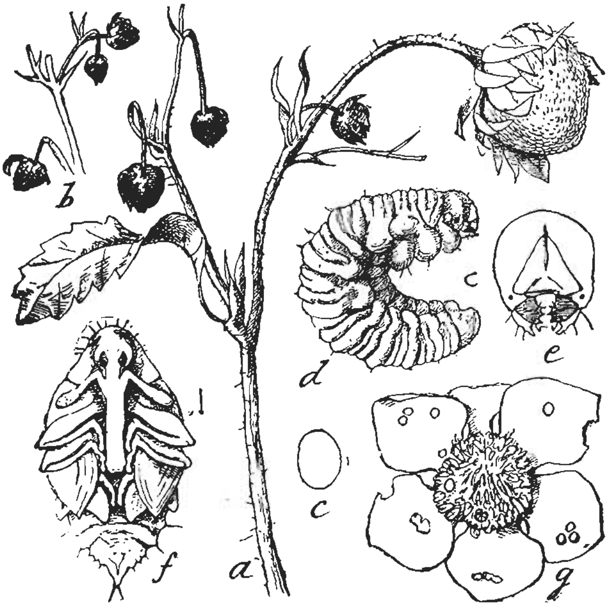


Fig. 174.—Strawberry weevil and its work. a and b, strawberry fruit stem showing the effect of bud cutting; c, egg of weevil; d, grub; e, head of grub; f, the pupa or stage into which the grub transforms when matured; g, injured bud opened up. (U. S. D. A.)

much of the soil remains untilled. This enemy is worse if the patch is planted on ground which has been in sod for several years.

Leaf-spot is probably the worst fungous disease. Its name describes its attacks of the foliage. This and other diseases are kept under control fairly well by mowing and burning the vines after picking.

Picking.—Strawberries should be picked as soon as they are colored, as remaining on the vines robs the plants of much strength, and berries are less injured if picked early. The calyx should remain attached to the berries. Pinch the stems and avoid handling the berries. Pick into small boxes holding one quart and sort for market during the picking process. Carriers or trays holding six or more quart boxes are used by pickers. At a central shed commercial growers often repack berries as they are brought from

the pickers. The berries are at least "faced up" to improve the appearance.

Life of Patches.—In the southern regions where fields are set in early spring, each setting of strawberries produces about two or three main crops. In northern states two crops are usually the limit. Plants set in August usually bear a light crop the next season and possibly two heavier crops later.

If the patch is in matted-rows some growers plow up the center of the mat to form a new aisle, leaving the youngest plants of the patch to form new mats. This plan leaves a row of weeds, and violates all the arguments for rotation. New patches should be set on freshly prepared soil.

Raspberries and Blackberries

Rich, black loams are best for all types of raspberries and blackberries. They are much less thrifty in light soils. Applications of manure and fertilizers are very effectual in producing better yields.

Locating the Patch.—Plan to locate these plantations where they may be undisturbed for some years and where they will be out of the way of other garden crops. Place them handy for frequent picking but never in the shade of trees as an open exposure is usually best. Avoid exposure to hot, west winds in regions where they are serious.

Types and Varieties.—Raspberries are of two main types in America. (1) The so-called red raspberry group including the red, purple, and yellow berries. Varieties in this group are Cuthbert, Herbert, King, Philadelphia, Marlboro, Ranere, and Perfection. (2) The blackcap group including such varieties as Blackcap, Cumberland, Farmer, Gregg, Kansas, Ohio, and Palmer, all of which are black. Varieties of other colors in this group are Catawba (purple-red), Columbian (purple), Golden Formless (yellow), Purple Cane (red). Ask your station to suggest the best.

Blackberries are of many different types from the botanist's point of view. Important varieties are Snyder, Early Harvest, Eldorado, Taylor, Ward, Erie, and Ancient Briton.

Dewberries are closely related to blackberries. Lucretia and Loganberry are standard and Young is a new commercial variety.

Propagation.—Raspberries of the blackcap type are chiefly propagated by tip-layering. This is usually done in the last half of the summer after picking is over. Tips are bent over and pegged or held by clods on the soft soil. After rooting they are severed from the parent plant by the use of a pruning hook or spade. Red

raspberries are commercially propagated by suckers. Blackberries will readily propagate by root cuttings or suckers. Pieces of root are dropped in shallow furrows as in planting Irish potatoes.

Planting.—The best time for planting is in the spring, but fall planting is sometimes practised. Discard all that have any signs of crown gall. (*Fig.* 175.) Set the plants a little deeper than they were in the nursery soil and firm the dirt about the roots well. Raspberry plants are set in rows about five or six feet apart, the plants being three or four feet apart in the rows. If cultivation in both directions is desired they may be set five feet apart each way. The first-mentioned plan is better for red raspberries because of their freedom in forming suckers.

Blackberries should be set in rows from six to nine feet apart. Set the plants three or four feet apart in the rows.

Intercropping.—Grow cultivated crops between the rows for at least one year to help maintain the cost of the patch until bearing time. Use early potatoes, cabbage, beets, beans, peas and other garden crops. Maintain clean culture constantly.

Pruning.—In the dormant season use pruning hooks and remove the oldest canes in each raspberry clump, leaving those of the last season's growth. Each summer the long canes should be cut back to cause branching and induce the formation of more fruit clusters. Some growers do the main pruning just after picking instead of in the winter.

FIG. 175.—Crown gall on raspberry. The same attacks peach trees. (Illinois Station.)

In southern regions blackberries may be pruned by mowing the entire patch with brush scythes just after picking. These vines should be removed and burned to destroy insects and diseases. (Fig. 176.) Farther north a few of the youngest shoots are left each year and the rest all removed as suggested. Cutting back tall canes during their growth will induce branching and increase yields.

Training.—Red raspberries are so tall that they often need some support. A good plan is to have a strong stake for each plant as shown in figure 177.

Winter Protection.—As growth continues until fall, winter killing of the bushes is often experienced. Plans to protect them during the winter are of several kinds. The canes are often laid down in a furrow alongside the row. Here they are covered with a light layer of soil or a good mulch of straw. This is better suited to slender varieties than to those with heavy canes. They are left covered in the spring until all danger of frost is over.

FIG. 176.—Orange rust on leaves of blackberry. (Illinois Station.)

Enemies.—Cane borers are serious in raspberry patches. They attack canes and cause the tips to droop. These should be trimmed off and burned. Cut well below the drooping part. The pithy gall-maker attacks the canes of blackberries, causing reddish pithy swellings one to three inches long. It may be controlled by cutting away the parts and burning them. Crown-gall on the roots of raspberries is often very serious. Eliminate any plants showing signs of the trouble at planting time. Never plant on soil where the disease has been known. Heavy applications of lime on such soils help. Anthracnose and cane blight are chiefly controlled by use of varieties most immune to the disease. Cut out the affected canes and burn the prunings, and use cultural methods which will stimulate growth. Bramble rust of an orange color affects both blackberries and raspberries. The annual pruning already described will aid greatly in controlling the disease if the prunings are burned and clean culture is practised after picking time. Spraying is seldom practised against raspberry and blackberry diseases.

Picking and Marketing.—Raspberries of all varieties should be picked as soon as they show the proper color. As extra handling is injurious, the pickers should use the boxes in which marketing is to be done. All trash should be avoided at that time. Marketing is usually in shallow boxes holding one pint or one quart to avoid mashing.

Blackberries of several varieties change to the ripe color before they are mature. For market purposes they may be picked at that time but for home use or local markets they may remain on the bushes longer. Pickers frequently wear gloves with the tips of the fingers cut away.

Profits from small berry patches are usually good. Berry boxes in crates may be shipped rather long distances if necessary. Surplus products are used by preserving, canning, and drying.

Currants and Gooseberries

These crops are chiefly grown in northern sections where the climate is cool as they do not endure hot, dry summers. They thrive best on rich soils which are not too light, much moisture being required by the roots. As the roots are shallow, mulches over the soil protect the roots from heat and dry weather. Strawy barnyard manure forms a good mulch for this purpose.

Fig. 177.—One-year-old red raspberries grown by the hill system, supported by single stakes. (U.S.D.A.)

Location.—Home plantations may be made along the edge of the garden, but allow for their cultivation on both sides of the rows. As the plants are permanent they should be placed where they will not be disturbed by the annual garden.

Types and Varieties.—Red currants and their albino variety are much more popular than the European black currants. The most popular red varieties are Fay and Cherry. (Fig. 178.) Popular varieties of American gooseberries are Downing, Pearl, and Houghton. European varieties grown somewhat on the Pacific coast and elsewhere are Industry and Chautauqua. Varieties which resist mildew fairly well are Champion, Eagle, and Snowball.

Propagation.—Both of these types of fruit are readily propagated by cuttings of ripened wood. Mound layering is also practised, particularly for gooseberries.

Planting may be done in either fall or early spring, fall being

preferred. Red currants should be in rows about five feet apart and three or four feet apart in the rows. Black currants are planted farther apart. Gooseberries are set in rows about six feet apart and the plants about four feet apart in the rows. In all cases try to use plants which have grown in the nursery one year from the cuttings.

Pruning.—Red currants produce their fruit on spurs which develop from the wood two or three years old. In pruning cut out only the canes that are older than this. Black currants and gooseberries bear the fruit chiefly on wood of the present year's growth. Canes older than two years may be pruned away annually.

FIG. 178.—The cherry variety of red currant has large berries and dense clusters. (New Jersey Station.)

Enemies.—Currant borers of two kinds burrow into the canes, often killing them. When noticed, affected parts should be cut away and burned. The currant worm or sawfly eats the leaves of both currants and gooseberries. It is controlled by poison sprays. The currant maggot and the gooseberry worm attack fruits just before or about ripening time. Larvæ inside the fruit render it worthless. They are best controlled by keeping poultry in the patch to eat larvæ when they fall.

Mildew is probably the worst disease of gooseberries, attacking the leaves, twigs and fruit. Immune varieties already mentioned should be grown. Spray with lime-sulfur in winter, early spring and summer. Both black and red currants are affected with leaf-spot disease, causing leaves to fall. Ammonia copper carbonate is used if the berries are about to ripen. Bordeaux mixture may be used after picking the currants.

Picking.—In America gooseberries are usually picked when full grown before they ripen. European varieties grown on the Pacific coast are often used in the ripe form. They are marketed in small berry boxes and are used for pies and sauce.

Currants are picked as soon as they color before they are too ripe. The whole cluster should be picked without injury. The picker should lay them into the berry boxes in which they are to be marketed as extra handling is injurious. They are relished for making jelly and sauces.

GRAPES

For home use or for commercial purposes grapes are grown in all parts of America. Suitable types may be found for all climates and the fruit is much prized by everyone.

Soils.—Grapes prefer medium or sandy loams rather than heavier soils, but almost any good garden soil will grow grapes successfully. The use of green manure and barnyard manure to add organic matter to the soil is recommended for all new plantations unless the soil be very rich.

Locating the Vineyard.—Make the plantation near the home where the fruit may be carefully watched from thieves, birds, and attacks of insects or diseases. A permanent grape arbor is often made to supply a few grapes for home use. Commercial plantations do best on hillsides having good drainage. Southern slopes are better than western or northern. Late spring frosts seldom injure the crop because the fruit is borne on shoots formed the same year, but unusually late freezes may injure these shoots and prevent a crop.

Types and Varieties.—There are three main types of grapes from the grower's point of view, but many botanical species have many varieties of each type. (1) Southern bunch grapes are best suited for growth in southern states. Good varieties are Headlight, Herbemont, Brilliant, and Bailey. Vinifera varieties may be included in this group. (2) Muscadine grapes are grown chiefly from North Carolina and Kentucky southward. The grapes are borne singly or in small clusters. Leading varieties are Scuppernong, James, Thomas, Memory, and Luola. (3) Northern bunch grapes are suitable for growth in all parts of the country. We have a large assortment of varieties. When ripe they vary in color: Purple or black, red or yellowish, white or greenish. The most popular varieties of these colors are Concord for black, Delaware for red, and Niagara for white. (Fig. 179.)

Vinifera grapes include nearly all the varieties grown in irrigated regions of southwestern states and the Mediterranean region. They are commonly found in our markets, being used for dessert purposes, for raisins and for drinks.

Propagation.—Ripe-wood cuttings made in the fall or winter bearing one to three buds are commonly used to propagate most types of grapes. (Fig. 180.) Cuttings are stored in damp sawdust in cool cellars until spring frosts are over. They are then planted in rows in gardens or nurseries where they remain for one year

FIG. 179.—White Niagara grapes ready for harvest. (Rittenhouse.)

under clean culture. They are then ready to transplant to permanent vineyards.

Planting.—Bunch grapes are usually planted in rows each way, for clean cultivation eight or ten feet being allowed between the rows. Muscadine grapes are given a little more space. Either spring or fall planting will be successful.

Grape Trellising.—Many forms of trellises are adopted. Each should suit the system of pruning that is to be followed. Horizontal wires supported on a line of posts is the most popular form of trellis. (Figs. 181 and 182.) Muscadines should be on a broad, spreading trellis. Vinifera grapes are pruned back each year to short stubs which are borne on trunks which become heavy as the vines grow older. No trellis is then needed.

Pruning.--As blossoms and fruit are formed on shoots made that spring only a few old canes are necessary to produce plenty of shoots for the crop. The rest may be pruned away each year. Be sure to leave a few of last year's growth bearing healthy buds. Usually these canes should be selected near the lower part of the trellis. As new growth starts each year tie the shoots to upper parts of the trellis. Figure 181 indicates a good system.

Cultivating and Fertilizing.—Clean cultivation between the rows is highly important. Begin in the spring by turning under a cover crop between the rows. Harrow the surface at least until mid-summer and then sow another cover crop for winter.

Fertilization is most important on very light soils. While the vines are young this may well consist of barnyard manure. When commercial fertilizers are used have a good supply of phosphate and potash and a small proportion of nitrogen.

FIG. 180.—Four types of hardwood cuttings: mallet, heel, single-eye, and simple cutting.

Enemies.—Rose-chafers eat the surface of the leaves, leaving the skeleton. As they are hard to poison, growers jar them off on stretchers of cloth and destroy them. Spraying for diseases and other insects will sometimes repel rose-chafers.

Leaf hoppers are often bad in vineyards. They suck the juices from the under sides of leaves. Strong kerosene emulsion is theoretically the best remedy, but the hoppers are hard to hit with the spray. A projection from the nozzle extending a foot in front of it may be used to lift the leaves during the spraying process. Repellant sprays will help. Flea beetles are seldom injurious when vines are regularly sprayed with poisons.

The grape-leaf folders may be picked off by hand or poison sprays may hold the pests in control.

Grape-vine phylloxera is chiefly injurious to the vinifera grapes as in southern California and foreign countries. They attack the leaves, but do no damage on the roots. The vines are frequently killed. The root form of this pest is best controlled by grafting the grapes on resistant stocks. Certain American stocks are used for this purpose.

Diseases of several kinds attack grapes. Black rot is doubtless the worst. Downy mildew and other mildews are often prevalent. Spraying with Bordeaux mixture (4-4-50) early in the season and continuing until about picking time is recommended for these grape diseases. Use the spray as a preventive rather than as a remedy. (Fig. 182). Combining poisons with Bordeaux mixture is economical as both insects and diseases are controlled. Ammonia copper carbonate washes off more readily than Bordeaux and may be used as ripening time approaches.

Picking.—Carefully pick bunches by the stems without touching the fruit. (Fig. 183.) Lay them gently in firm baskets or crates as they are to be sent to market. Some varieties should be picked as early as the color will warrant, while others should

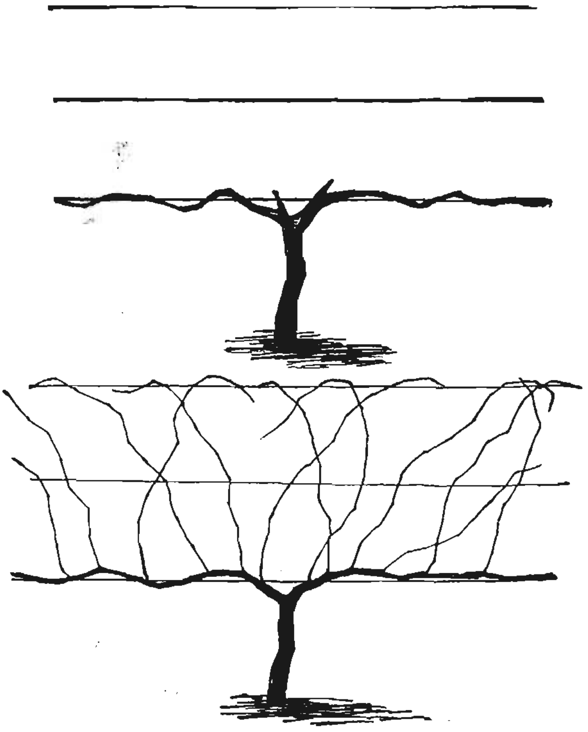


FIG. 181.—The upright or high-renewal system of pruning and training grape vines. The wires are stretched at 24, 40, and 56 inches from the ground. Upper view is just after pruning. The fruiting shoots from the two canes are trained upright and tied to the upper wires, as shown below.

remain on the vines a little longer, particularly if they are to be used at home or in local markets. Fill the packages for market full enough so that the cover will press the fruit together and prevent jostling after the bunches relax. When packing grapes for long shipments, they are allowed to wilt for a day before containers are closed. This allows firmer packing of the fruit. (Fig. 184.)

Field Trips, Exercises, Projects, and Problems

1. **A local survey** for small fruits should include varieties grown; criticisms of varieties; cultivation; annual labor cost; fertilizers; insect enemies; diseases; trellising; pruning; uses; yields; prices.

2. **Problems** based on the survey may be similar to those suggested for orchard fruits.

3. **Charts** for small fruits may well be made showing lists of enemies, and their remedies; varieties arranged by season of ripening; a list of

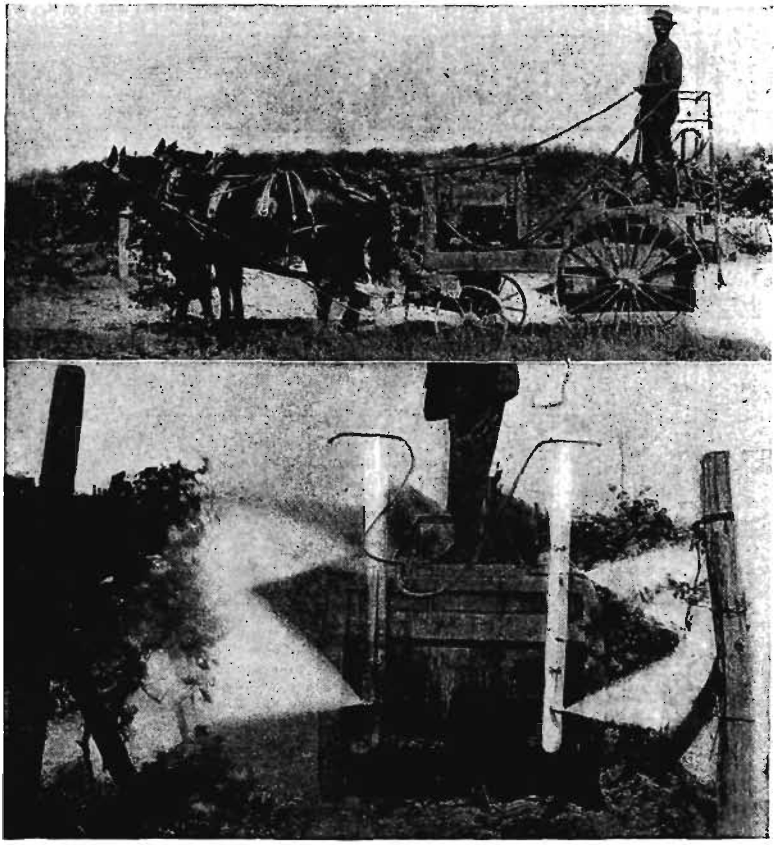


FIG. 182.—Gasoline engine sprayer with three nozzles on each side arranged for spraying grapes supported on three-wire trellises. Side view shown above. (Geneva, N. Y., Station.)

small fruits with place of bearing the fruit; income per acre for each of the small fruits.

4. **Debates.**—"Blackberries *vs.* raspberries for profit." "Home propagation *vs.* purchasing from nurseries." "Grapes *vs.* strawberries for profit."

5. **Field trips** should be made to places where students can observe and, perhaps, practise pruning, trellising, propagation, observe the work of enemies, picking, packing, and marketing. Visit markets to study containers, prices and condition of fruits.

6. **Small fruit projects** should include large enough plantations to give plenty of practice in all of the chief operations. A young plantation may be started and an older one may be managed at the same time. Propagation of the fruits may well be included. Trials with projects may com-

FIG. 183.—Picking and packing grapes in the vineyard. (Cornell Memoir 28.)

FIG. 184.—Putting covers on grape baskets in preparation for hauling to shipping station. (Cornell Memoir 28.)

pare different varieties, systems of trellising, differences in pruning, variations in spraying campaigns, differences in mulching or fertilizing, different methods of marketing.

7. **Exercises** in the laboratory may include the study of diseases and insect enemies of the small fruits, blossom studies and fruit formation. Practise propagation, and fruit judging.

Questions and Investigations

1. Name the several small fruits in order of importance in your region.
2. What soils are best for strawberries? For raspberries?
3. Describe the preparation of soils for strawberries.
4. List good varieties for your region.
5. How would you secure plants?
6. Describe three plans of setting strawberries.
7. Debate hedge-row *vs.* matted system, pro and con.
8. Describe enemies which are worst locally; give remedies.
9. Give directions for picking commercially.
10. Give life of commercial plantations.
11. Compare raspberries and blackberries in soil requirements, distances of planting, and culture.
12. Describe the propagation for each.
13. Give directions for pruning each.
14. What are the most serious enemies? Give remedies.
15. Give directions for picking and marketing.
16. Where would you locate plantations of currants and gooseberries?
17. Tell of their types and varieties.
18. Describe the propagation of each.
19. Describe the annual pruning of each.
20. Give control methods.
21. Where would you locate your vineyard?
22. What are the three main types of grapes? Which would suit your region?
23. Give your choice of varieties.
24. Describe grape propagation.
25. Give distances for planting.
26. What plan of grape trellis would you prefer?
27. Give directions for annual pruning.
28. Give advice for annual cultivation and fertilizing.
29. What are the worst insects and diseases? Give remedies for each
30. Give directions for packing and marketing.

Farm Mechanics.—Make up fruit containers; box carrying trays; arbors; planters; stakes. Repair arbors, runner cutters, cultivators, pruners, dusters, sprayers.

Calculations.—1. Find how many strawberry plants are required per acre by each of the three plans of setting: (*a*) matted rows 4 ft. by 2 ft.; (*b*) hedge rows 30 in. by 18 in.; hill rows 2 ft. by 2 ft.

2. If plants cost $3 per 1,000, find the total cost for plants and labor by each method of setting an acre, providing setting costs $1 per 1,000.

3. Yields per acre by the three above systems for two crops each were found to be as follows: Matted rows 2,000 and 3,000 qts.; hedge rows 5,000 and 7,000 qts.; hill rows 4,000 and 6,000 qts. If the first crop from each system sold at $2 a crate of 24 qts. and the second crop of each sold at $1.80 a crate of 24 qts., find the income from each plan.

GARDEN ENTERPRISE

Analysis into Jobs.—The main teaching units in the garden enterprise are here listed. The references given are to pages in *New Agriculture*, and numbers of *U. S. Farmers' Bulletins*. See *Horticulture Enterprises* and *Southern Horticulture Enterprises*.

1. **Deciding whether or not to grow a garden,** p. 275; *Bulletins*, 1044, 1242. *Local inquiry.*—(*a*) Ask a number of families whether or not they have a home garden and whether or not they sell some products. (*b*) Find the reasons of those who do not have gardens. (*c*) What encouragement for gardening is given by those who have gardens?
2. **Selecting, soil and location,** pp. 39, 275. *Local inquiry.*—(*a*) Ask garden growers regarding the best soils and best locations for gardens. (*b*) What changes in heavy or light soils are made by local growers?
3. **Choosing crops and varieties,** pp. 276–279; *Bulletins*, 232, 354, 433, 1205, 1338, 1394, 1396, 1563, 1609, 1620, 1646, 1673. *Local inquiry.*—(*a*) Get a list of the garden crops grown in local gardens and the varieties of each. (*b*) Get the owners to compare these varieties.
4. **Deciding how much to plant,** pp. 277–279; *Bulletins*, 1190, 1673. *Local inquiry.*—(*a*) Find the amounts grown of each garden vegetable for home use. (*b*) Ask advice of local growers regarding the amount to plant for each of the market vegetables. (*c*) Find how large areas one person can attend for each of the market vegetables.
5. **Planning the garden,** pp. 276–279; *Bulletins*, 218, 1044, 1242, 1673. *Local inquiry.*—(*a*) Find what gardeners draw plans before the gardening season. (*b*) Draw a plan of a good local garden from the description of the owner.
6. **Obtaining garden seeds. Testing. Treating,** pp. 277, 279; *Bulletins*, 428, 434, 799, 948, 1232, 1242, 1332, 1390, 1436. *Local inquiry.*—(*a*) Get the opinions of gardeners regarding the best methods of obtaining seeds. (*b*) Ask what relation this job bears to disease resistance, to quality, to earliness. (*c*) Get their reasons for and against testing, treating and soaking.
7. **Starting and managing hotbeds and coldframes,** pp. 279, 282; *Bulletin*, 1673. *Local inquiry.*—(*a*) Find what growers use hotbeds or coldframes. (*b*) Describe the best of each found locally. (*c*) What crops are started in hotbeds? In coldframes? (*d*) Find about what dates hotbeds and coldframes are planted.
8. **Selecting tools and implements,** pp. 276, 282, 283; *Bulletin*, 1673. *Local inquiry.*—(*a*) Make a list of hand tools and implements used by local growers and find the special uses of each. (*b*) What growers use hand wheel implements for planting? For tillage?
9. **Preparing garden soils,** pp. 39, 282, 283; *Bulletins*, 921, 999, 1250, 1475, 1529, 1606, 1635, 1673. *Local inquiry.*—(*a*) Find what gardeners make a compost heap for rotting manure for gardens. (*b*) Find their plans. (*c*) What growers use the bare-fallow plan in preparing garden soil? (*d*) What commercial fertilizers are used by local growers?

10. **Seeding and transplanting**, pp. 282, 284–300; *Bulletins*, 1253, 1646, 1673. *Local inquiry.*—(*a*) What proportion of local growers discriminate between cool-weather and warm-weather crops when seeding? (*b*) Of the rules on page 284, which ones are most commonly violated? (*c*) Describe the best transplanting of cabbage; of tomatoes; or other vegetables.
11. **Cultivating the garden**, pp. 73, 74, 75, 285–300; *Bulletins*, 1255, 1529, 1563, 1609, 1620, 1635, 1646. *Local inquiry.*—(*a*) How many of the local gardens are planted in long rows far enough apart for cultivating with a horse? (*b*) How many growers depend mostly upon hand hoeing? (*c*) Find what implements are used in garden cultivation and compare these. (*d*) How frequently are gardens cultivated? (*e*) Inquire as to the relation between rains and frequency of cultivation.
12. **Weeding, hoeing and thinning**, pp. 285–300; *Bulletin*, 1307. *Local inquiry.*—(*a*) What weeds are considered most troublesome in local gardens? (*b*) Ask growers how they control them. (*c*) Compare the costs of hoeing and of horse cultivation. (*d*) Find what vegetable crops require thinning and get the distances for each. (*e*) Ask growers how thinning expenses could be reduced.
13. **Controlling diseases and insects**, pp. 285–300; *Bulletins*, 739, 835, 940, 959, 1059, 1060, 1247, 1367, 1371, 1439, 1498, 1624. *Local inquiry.*—(*a*) Make a list of insects and diseases which are serious in local gardens and the crops which they most affect. (*b*) Study methods of controlling them as practiced locally.
14. **Harvesting and marketing**, 285–300; *Bulletins*, 1050, 1064, 1144, 1145, 1233, 1253, 1255, 1291, 1563, 1579, 1594, 1609, 1620, 1646. *Local inquiry.*—(*a*) Ask growers which of their garden crops must be harvested very punctually. (*b*) Which others do they find have a long range of time? (*c*) Find how they manage to use or market those included in (*a*). (*d*) Get the arguments for and against coöperative marketing of vegetable crops.
15. **Storing**, pp. 285–300; *Bulletins*, 847, 879, 1267, 1442. *Local inquiry.*—(*a*) What local garden crops are most commonly stored? (*b*) Describe the best storage methods you can find for each of these crops. (*c*) Ask growers regarding the losses during storage. (*d*) Ask them regarding the advantages from storage.
16. **Keeping records**, pp. 18–19; *Bulletins*. 511, 572, 782, 1139, 1182, 1564. *Local inquiry.*—(*a*) Ask farmers to compare the cost of production with the returns from gardens. (*b*) Find what records are kept by the best gardeners. (*c*) Make a list of the jobs involved in gardening and get other growers to estimate the cost of each job for a given area. (*d*) Compare these results with different crops.

CHAPTER XVIII

GARDEN ENTERPRISE

VEGETABLE gardens are of several types, some for home use and others for market purposes. Commercial gardens are of three main types: (1) Market gardens, which grow a general assortment of vegetable crops of many kinds for the purpose of keeping the local market supplied with all its needs; (2) truck gardens are used for the production of one or two special crops in large quantities for shipment to markets in distant places. For example, the truckers in the irrigated regions of the Imperial Valley, California, may ship their cantaloupes to markets as far distant as New York; (3) growing vegetables for factories, as canning and pickling.

Gardens grown by farmers and village people may supply the home table with fresh (and canned) products for several months each year and greatly reduce the actual outlay of money for table supplies. Simple garden equipment and tools are shown in figures 185 and 186.

Garden Soils.—In selecting soil for the garden choose the richest. For most garden crops soil cannot be too rich. Deep black soil with plenty of organic matter gives best results for the earliest crops. A good mixture of sand is helpful. It aids greatly in the warming of soils in the spring, and early crops depend upon this. Soils that are either too light or too heavy may be greatly improved by large quantities of barnyard manure and green manure. On sandy soils allow several weeks between the plowing under of large amounts of organic matter and planting time, or thoroughly mix the soil and manure together by disking.

Locating the Garden.—(1) The labor of cultivating the home gardens by hand often causes them to be abandoned or neglected. Place the garden where it will be easy and handy for the use of plows and cultivators on days when these implements are being used in field work.

(2) Place the garden where it will not be difficult to keep out poultry and livestock; perhaps on the opposite side of the house from the other farm buildings will aid in this matter.

(3) If possible place the garden where it will have a southern exposure and be free from shade of large trees and buildings.

(4) Have the garden near the home where vegetables may be

frequently secured for table use and where marauders will not venture.

Classification of Garden Crops.—Before planting of spring

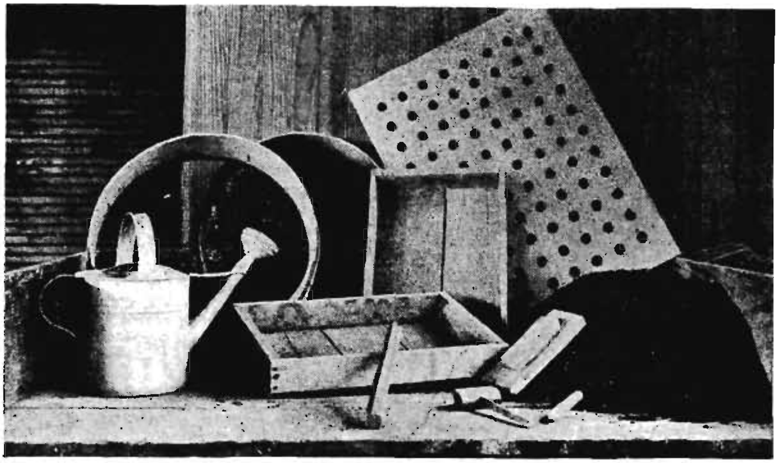


FIG 185.—Tools and materials used in growing early plants: sprinkling can, sieves flats, marking stick, dibbles, firming block, spotting board, and mixed soil. (Pennsylvania Station.)

gardens it is important that students understand well the proper seasons for growing each of the garden crops. For this purpose they may be divided into three main groups:

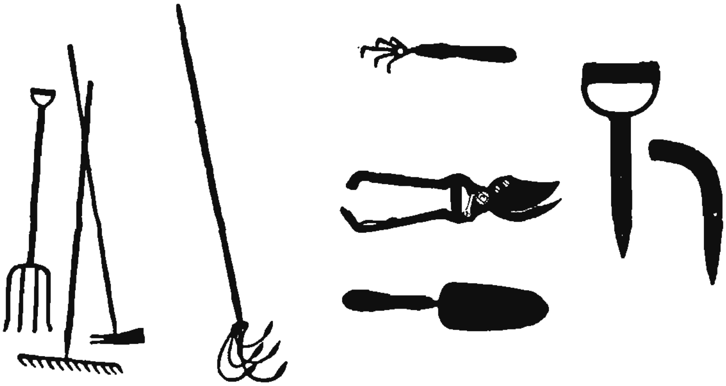


FIG. 186.—Inexpensive, handy garden tools: spading fork, rake, hoe, hand cultivator, hand weeder, pruning shears, trowel, two dibbles.

(1) Those which endure frost, as lettuce, spinach, mustard, radishes, turnips, peas; and transplanted crops, such as head lettuce, cabbage, cauliflower, brussels sprouts, broccoli and celery.

Farm Garden Record. Dates are for Latitude of Kansas (Kansas Station)

Vegetable	Varieties in order of production	Date of setting or planting	Amount of seed	Depth of planting, inches	Distance between rows, feet	Distance apart in row, inches (or feet)	First picking	Last picking	Yield to 100 feet
Beans	Stringless Green Pod	May 10	1 pt. to 50 feet	2 to 3	3	6	June 27	July 18	48 qts.
	Bush Lima	May 10	1 pt. to 50 feet	2 to 3	3	6	June 27	July 18	46 qts.
Beets	Crosby's Egyptian	April 6	1 oz. to 50 feet	½	1 to 1½	2 to 4	June 11	Sept. 11	450 lbs.
Cabbage	Premium Flat Dutch	April 24	1 oz. to 1500 plants	½	3	24	June 27	July 21	41 heads, 54 lbs.
	Early Jersey Wakefield	April 24	1 oz. to 1500 plants	½	3	24	June 27	July 21	45 heads, 52 lbs
Carrots	Early Chantenay	April 1	1 oz. to 100 feet	½	1 to 1½	2 to 4	July 20	Nov. 1	240 lbs.
	Half Long Danvers	April 1	1 oz. to 100 feet	½	1 to 1½	3 to 5	Aug. 10	Nov. 4	120 lbs.
Celery	Giant White Pascal	July 13	1 oz. to 3000 plants	⅛	3 to 4	6		Sept. 28	180 heads.
	White Plume	July 13	1 oz. to 3000 plants	⅛	3 to 4	5		Sept. 15	220 heads.
Cucumbers	Arlington White Spine	May 8	1 oz. to 50 hills	½	4 to 6	4 to 6 ft.	July 25	Sept. 20	1799, 150 lbs.
Lettuce	Black Seeded Simpson	April 12	1 oz. to 150 feet	½	1	3 to 4	May 28		264 lbs.
	Improved Hanson	April 12	1 oz. to 1000 plants	½	1	3 to 4	June 1		244 lbs.
Onions	Giant Gibraltar	April 12	1 oz. to 100 feet	½	1	3 to 4	Aug. 22		28 lbs.
	Prizetaker	April 12	1 oz. to 100 feet	½	1	3 to 4	Aug. 22		21 lbs.
Parsnips	Hollow Crown	April 12	1 oz. to 200 feet	¼ to 1	1½	2 to 4		Oct. 9	56 lbs.
Peas	Nott's Excelsior	April 12	1 qt. to 100 feet	3	3 to 3½	1 to 2	June 8	July 19	21 lbs.
	Gradus	April 12	1 qt. to 100 feet	3 to 4	3½	1 to 2	June 8	July 19	20 lbs.
Radishes	Early Scarlet Turnip	Mar. 22	1 oz. to 100 feet	½ to 1	1	1 to 2	May 1	May 20	3077 roots.
	White Strassburg	April 10	1 oz. to 100 feet	½ to 1	1	1 to 2	May 20	June 1	2607 roots
Salsify	M. Sandwich Island	April 25	1 oz. to 70 feet	½ to 1	1½	2 to 4		Sept. 4	50 lbs.
Spinach	Victoria	Mar. 25	1 oz. to 100 feet	1 to 2	1 to 1½	2	May 11	June 17	75 lbs.
Squash	Summer Crookneck	May 16	1 oz. to 20 hills or 8 to	1 to 2	7 to 8	7 to 8 ft.		Aug. 7	13 squash, 39 lbs.
	Hubbard	June 20	12 seeds per hill	1 to 2	10 to 12	10 to 12 ft.		Sept. 9	9 squash, 35 lbs.
Sweet Corn	Mammoth White Cory	April 20	1 qt. to 200 hills, or	2	3	2½ to 3 ft.	June 23	July 16	91 lbs.
	Stowell's Evergreen	April 20	¼-qt. to 100 feet	2	3	2½ to 3 ft.	June 23	July 16	87 lbs.
Tomatoes	Earliana	May 12	1 oz. to 1500 plants	½ to 1	4	4 ft.	July 12	Sept. 18	420 lbs.
	Stone	May 12	1 oz. to 1500 plants	½ to 1	4	4 ft.	July 12	Sept. 18	405 lbs.
	Dwarf Champion	May 12	1 oz. to 1500 plants	½ to 1	4	4 ft.	July 12	Sept. 18	217 lbs.
	Trucker's Favorite	May 12	1 oz. to 1500 plants	½ to 1	4	4 ft.	July 12	Sept. 18	230 lbs.
Turnips	Early White Milan	July 3	½-oz. to 100 feet	¼ to ½	18 in.	6 in.	Aug. 15	Oct. 1	150 lbs.

(2) Cool season crops which endure summer heat, as beets, carrots, chard, kale, collards, New Zealand spinach, parsley, endive, onions, challots, leeks, chives, potatoes, asparagus, rhubarb, globe artichoke and seakale. To this may be added parsnips, salsify and horse radish, which endure winter freezing as well as summer heat.

(3) Warm season crops, as corn, beans of all kinds, okra, melons, cucumbers, squashes, pumpkins, and four that need transplanting: tomatoes, egg plants, peppers, and sweet potatoes. None of these endure frost.

Beginners are too apt to plant beans and peas and lettuce at the same time. Some novices even plant early cabbage, corn, and melons before frost is over. They should note carefully the groups in which the garden crops are placed.

Planning the Home Garden.—The shape of the garden should be somewhat rectangular with the rows running the long way. This makes less turning and less waste space when horse implements are being used. The direction of the rows should, if possible, be at right angles to the slope to prevent washing. Never make small beds crosswise of the garden as it interrupts cultivation and causes tedious hand work.

Make a diagram of the garden showing each row, and write on each row the plants it is to contain. Show the spring plants and all succeeding crops for that year. First make a list of all the crops desired. On another sheet of paper group these according to season of planting. Then locate them on the diagram as suggested.

In locating the crops in the garden several principles should be borne in mind: (1) Perennial plants, such as asparagus and rhubarb, should be placed at one side where they will remain undisturbed for several years. (2) Place parsnips, salsify and other long-season crops together and next to the perennials. (3) Place the quick-growing crops, such as lettuce and radish, in the open part of the garden where the soil may be easily prepared for the following crops. (4) Place the vine crops, such as melons and cucumbers, where they will be least in the way while cultivating other crops; but place them with some tall crop, as sweet corn, growing between them, to help prevent cross-pollination. (5) Place the root crops, such as beets and carrots, where rotations will be easy in future years, because of the danger of root diseases. (6) Plan succession of crops in rows so as to keep the garden well occupied through the whole growing season, as lettuce followed by snap beans; beets followed by turnips.

Paste the diagram sheet, when completed, on a cardboard to

hang on a wall where it can be consulted throughout the summer. (Fig. 187.)

Securing Seeds and Plants.—Write for garden catalogues early. Advertisements in farm papers will supply the addresses. Get several. Study these to help determine varieties and learn variety names. If garden seeds have not been saved at home, it is a good plan to order fresh seeds from reliable seedsmen by mail. Local dealers often carry over old stocks and less success is probable if they be used. Try out some new vegetable occasionally.

Planning for Hotbeds and Coldframes.—The chief difference between a hotbed and a coldframe is that the former has extra bottom heat. This heat is usually supplied by placing fresh horse manure in the bottom which rots and produces the heat.

The purposes of hotbeds and coldframes are given: (1) To lengthen the time for growth of certain crops that do not mature outdoors, as tomatoes and sweet potatoes. (2) To grow quick-maturing crops in the winter or earlier in the spring than they could be grown outdoors, as radishes and lettuce. (3) For wintering over certain plants started in the fall. Hotbeds and coldframes are usually made six feet wide so that gardeners can reach in from the north and south sides. They

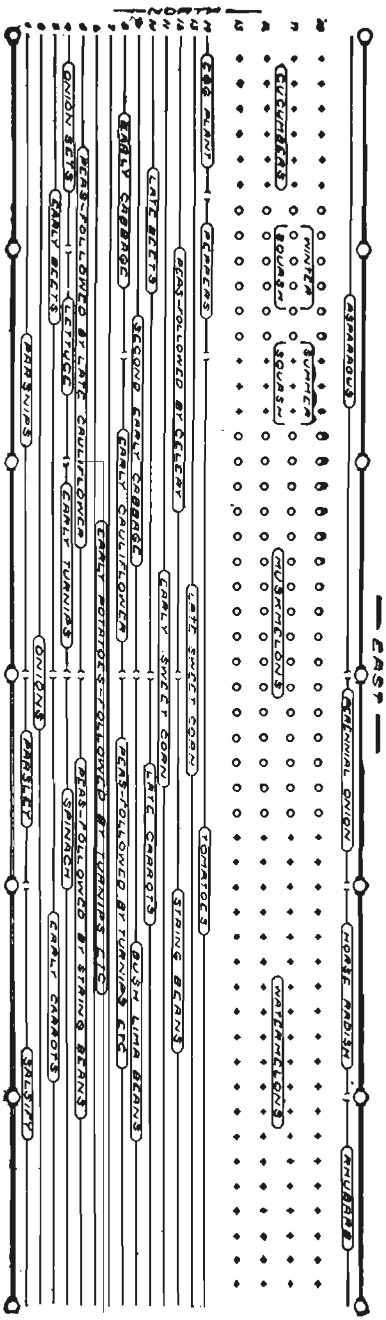
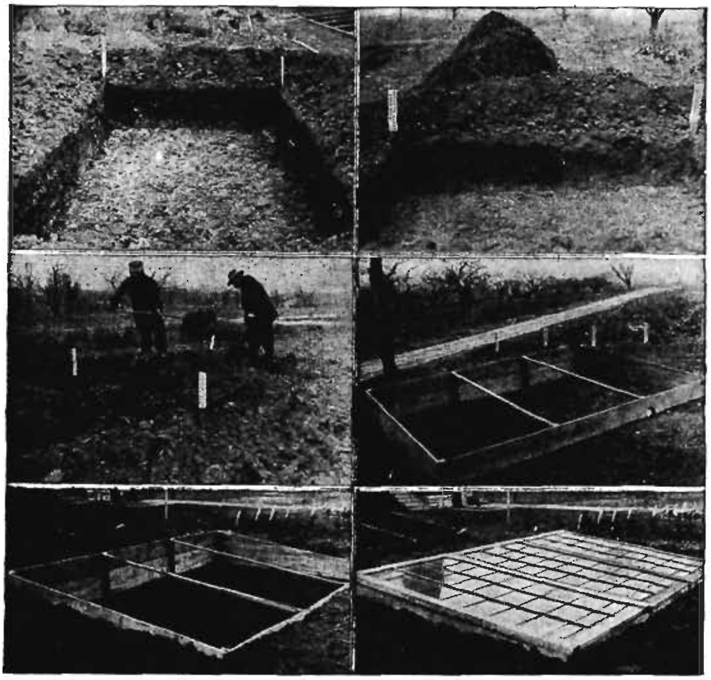


FIG. 187.—Plan for a home garden. (Pennsylvania Farmer.)

are made as long east and west as desired to give the room needed.

Steps in Making Hotbed.—Six steps in making hotbeds are shown in figure 188. (1) The soil is dug out for the bed of the size and depth desired. (2) Fresh manure is placed in the bottom to a depth of eight to twelve inches. This is tramped well. (3)

A B



A B

Fig. 188.—Steps in making a hotbed. Above, A, pit one foot deep; B, manure ready for the pit; centre, A, manure spread evenly and tramped; B, three-sash frame showing construction; below, A, frame in place over manure, which has been covered with soil, the sides of frame banked; B, the three-sash bed completed and covered. (Kentucky Station.)

About six inches of good garden soil is placed over this. (4) A frame is made six feet wide and, in this case, nine feet long. It is twenty inches high at the north side and twelve inches high at the south. (5) The frame is set in place and the soil is banked all around it. (6) Hotbed sash are placed over the frame and kept until the manure heat is just right for planting.

The coldframe would be made in the same way except that the manure is omitted. Cloth covers (Fig. 189) are sometimes used on coldframes instead of glass, particularly in southern latitudes.

Planting in Hotbeds.—From the classification of crops it is seen that a number of them are usually transplanted. These may be started in hotbeds in early spring and when of good size and the weather conditions are favorable, they may be transplanted to the open garden: Head lettuce, cos lettuce, cabbage, cauliflower, tomatoes, egg-plants, and peppers. The first four may be started in hotbeds earlier than the others.

In the colder climates, a few boxes of soil may be placed in a window in the house or other warm building for the starting

FIG. 189.—Winter and early spring seedbeds shaded with cloth. *This plan takes the place* of coldframes in mild weather. (Florida Station.)

of seeds of these crops. Sow the seeds over the surface or in close rows. Cover very slightly, water well, and cover with a newspaper until germination begins. When sprouted, keep the boxes in a light window until the plants form their second pair of leaves. They are then ready to transplant to the hotbeds or coldframes. When doing this, choose a warm, sunny day to avoid chilling the plants. Set them in the ground deeper than before, firm the soil around each plant with the fingers and let them stand about two inches each way. (Fig. 190.) More space may be given if the beds are large enough to allow it. If any space be left in the bed, use it for growing leaf lettuce and radishes.

Management of the Hotbed.—When plants in the beds have started growth, watch the ventilation and moisture conditions carefully. Keep the soil moist without making the plants too wet. Flooding the soil is better than watering the tops of the plants with a sprinkler. On hot days raise the sash to let out the humidity

and hot air. If cool winds are blowing, avoid blasting the plants during ventilation. This may be accomplished by lifting only one end of each sash. Damping-off fungus is very serious in poorly ventilated hotbeds.

A second transplanting in the hotbed is often desirable, particularly for head lettuce and cos lettuce. At that time give them more space and plant them deeper.

FIG. 190.—The hands should pack the soil firmly around the plant to draw moisture to the roots. A little loose mulch should be left on top. (Dunham Co.)

Preparation of Garden Soils.—For spring gardens in northern latitudes it is well to plow the soil the preceding fall. Farther south fall plowing and planting of cover crops is best. This cover crop may be disked or plowed under in early spring. In either section the soil should be thoroughly prepared in the spring before gardens are planted. Soils will warm up more evenly and quickly, and garden crops will start growth better. On top the soil should be friable and loose with no clods or rubbish. (Fig. 191.) Rake the surface evenly before laying off the rows. (Fig. 192.)

A Garden Compost.—In planning for a garden prepare a good garden compost. Have this ready for use at all times during the

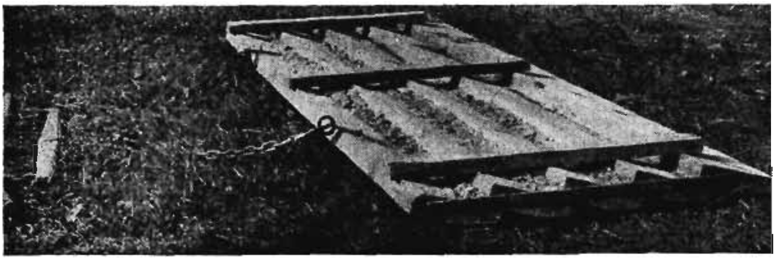


FIG. 191.—A home-made plank drag is useful in pulverizing clods, leveling the surface and firming the soil. (Pennsylvania Station.)

garden season. A good method of making a compost heap is given: (1) Spread a load of stable manure out level on the ground at one corner of the garden or beside it, preferably on the poorest soil or upper side of the garden. (2) Place over this a layer of tough grass sod containing plenty of roots and turf. (3) Next spread another layer of manure four to six inches thick. (4) Follow with another layer of sod. Continue these alternate layers as high as desired. Leave the surface level to absorb rainfall. If the weather is dry, water may be poured over it to start the decay. Instead of sod,

layers of vines from potatoes, tomatoes and other garden crops may be used. Weeds, marsh hay, straw and other materials are often used. A good time to start the compost is in late summer. By the following spring it is ready for use. If manure and litter rot for several months in a compost heap, weed seeds are often destroyed. Well-rotted material is better for the soil than fresh manure. When transplanting plants to the garden use plenty of compost along the rows.

Fertilizing the Garden.—If possible before plowing the garden spread a good layer of half-rotted barnyard manure over the soil to be plowed under. Plan to have a crop to plow under as often as possible and use plenty of compost during the growing season.

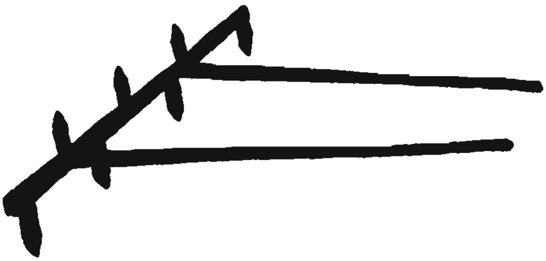


Fig. 192.—A simple marker for two widths of rows.

Commercial fertilizers may be used as desired. particularly for market gardens and truck crops. It is best to use available forms of fertilizers to stimulate the growth of crops at the right time. For leaf crops such as lettuce, salads and cabbage use nitrate of soda or dried blood. For root crops as beets and potatoes and for corn and tomatoes add some available phosphoric acid and potash.

Transplanting Hotbed Plants to the Garden.—Good judgment must be exercised in deciding when to transplant the plants from a hotbed to the open garden. The cool-season crops such as lettuce, cabbage and cauliflower should be transplanted first. Tomatoes, egg-plants, and peppers should wait until all danger of spring frost is over and until the soil is thoroughly warmed. Danger from cut worms is lessened by delay in transplanting these warm-season crops.

Do the transplanting when the soil is in good working condition, neither too wet nor too dry. If possible select a day when the sun is not too hot nor the wind too strong. Much transplanting is done in the latter half of the afternoon to avoid wilting. The plants revive better at night. Plants often need covering just after transplanting. Leaves from large weeds or leafy twigs from bushes

may be used. A shingle on the sunny side of each plant will afford protection.

Always water the plants in the hotbed before transplanting. If possible water the plants in the garden just after setting. (Fig. 193.)

For large areas transplanting machines (Fig. 140) described in the tobacco and sweet potato chapters are used for cabbage, lettuce, cauliflower and peppers. Tomatoes and egg-plants are rather too brittle for machine planting. The chief purpose in using machines is to hasten the work at the proper season and to water the plants economically. When labor is scarce machines are essential in truck gardens.

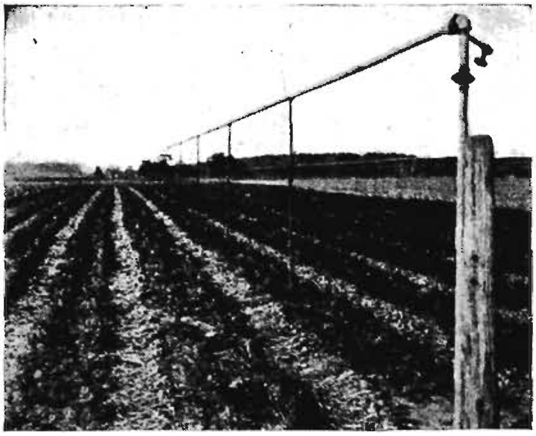


Fig. 193.—Truck garden with pipes for over-head irrigation, a good precaution against loss during dry weather, even in humid regions. (Skinner Irrigation Co.)

Rules for Planting Seeds.—The lists already given indicate the proper season and depth for planting the different garden crops. Several rules regarding methods will aid beginners: (1) In light soils plant seeds deeper than in heavy soils. (2) In dry soils plant deeper than in soils that are moist. (3) Small seeds should be covered very slightly. (4) Medium-sized seeds are covered a little deeper. (5) Large seeds as corn and beans, should be covered the deepest of all. (6) Very small seeds as onions, salsify, carrots and parsnips should have, planted in the row with them, some stronger-growing kinds as radishes to break the crust of soil at sprouting time and to mark the row for early cultivation. (7) Seeds with very dry seed coats as chard, beets and melons, are benefited by soaking in water over night before planting. (8) After planting seeds always firm the soil to bring soil moisture to the seeds.

Cool-Season Crops

Lettuce requires rapid, continuous growth to produce tender, well-flavored leaves and head. Select good, rich, moist soil for sowing the seeds or transplanting the plants from the hotbed. Sow fresh seed about every three weeks during the cool part of the year. Fall crops as well as spring crops may be produced. There are three main types of lettuce grown: (1) Leaf lettuce does not pro-

Fig. 194.—Boston head lettuce. Section showing solid texture and light color which help make the finest quality. (Cornell Reading Circle Leaflet.)

duce true heads. Some varieties have curly leaves and others smooth. It will stand cutting and grow from the crown again if weather conditions are good. It is sown in thick drills and may be thinned as used. (2) Head lettuce (Fig. 194) is more popular as a market crop than leaf lettuce. To produce heads several transplantings are advised. Stimulate the growth with plenty of manure or fertilizer. Lettuce heads better in cool climates and in cool weather. In southern regions it is grown in the fall as well as in the spring. Iceberg and Hanson are varieties well suited to fall growth there. Boston head lettuce is the most popular variety in northern latitudes. (3) Cos lettuce or Romaine, is midway between the other two in structure, but the leaves are taller than either It will endure summer heat better than the others

but should be started in cool weather of spring or allowed to have the advantage of cool weather in the fall. A little more time is required for its growth than leaf lettuce. It is becoming more popular than formerly.

Spinach is grown for greens and is one of the best plants for this purpose. It thrives best in cool seasons. It belongs to the beet family and the seeds are similar. Under favorable conditions it should be ready for table use six weeks after planting. One ounce of seed will plant about one hundred feet of drill. Cover the seeds only slightly but firm the soil well. Soaking before planting is a good practice. In the Gulf states it may be sown in the fall and will endure the winter without protection. In markets the spinach plants are commonly sold by weight or peck measure. The southern crop is shipped in crates or splint baskets and barrels to northern markets in very early spring.

New Zealand spinach endures hot weather well. Unlike common spinach it does not run to seed when hot days come. The young branches are pulled for use instead of taking the whole plant, and the crown will continue to form new growth during the season.

Mustard should be sown as early in the spring as soil conditions will allow. It may be either drilled in rows for clean cultivation or, if areas are large, it may be sown broadcast. The latter plan is practised for fall sowing in southern regions. The crop is harvested during open winter weather and in spring for shipment to large markets. Little covering of the seeds is necessary as they are small and spherical, rolling between soil particles when rains come. White mustard has dark green leaves and is smoother than the black mustard, which is stronger and more pungent.

Radishes to be relished must be tender and crisp. They grow best in cool days of early spring and late fall. Plenty of moisture is necessary, which makes fall growth less certain. Use plenty of manure in the soil. Sow the seeds in thin drills and thin the plants by using the largest first. In home gardens much of the radish crop may be grown by planting radish seeds with beets, lettuce, onions, peas, carrots and salsify, to help mark the rows and break the crust for those crops. Thus no extra space is required in the garden for the radish crop. Radishes develop quickly and may soon be out of the way of the other crops. When sown alone, allow one ounce of seed for fifty feet of drill. Harvest radishes before warm weather and before they become pithy.

Peas are of two main types in growth: the dwarf peas are

two feet or less in height and are grown without supports; the medium or tall ones need staking or trellising. For medium peas switches pushed in the ground will furnish sufficient support. The tallest varieties need more substantial trellises or poles. Pea seeds are of two main types, smooth and wrinkled. The former are hardier and may be planted earlier in the spring. Wrinkled varieties are planted a little later and are sweeter in flavor. None of the peas endure hot weather. For this reason they are grown much more in northern latitudes than in regions where the hot weather comes on too soon. Where summers are cool enough several plantings may be made in succession so that a crop may be available for use almost the entire summer and fall. Peas are extremely hardy and will stand the cold, frosty weather of early spring and should be started early enough to mature their pods before hot weather. Sow the seed in drill rows about one inch apart, one pound of seed in one hundred feet of drill. When sown broadcast for canneries, use about two bushels of seed per acre.

FIG. 195.—A small head of cauliflower of fine quality. (Cornell Reading Circle Leaflet.)

Cauliflower (Fig. 195) is sometimes called "educated cabbage." The methods of producing the crops are very similar. Cabbage is a little hardier than cauliflower, enduring more frosty weather. Seeds sown in hotbeds in January or February should produce plants ready for the open garden when freezing weather is over. *Sow seeds in May or June for the late crop.* Plants are set in rows in the garden fifteen to eighteen inches apart in the rows. Use plenty of manure or fertilizer to stimulate the growth. Moist conditions should prevail if the crop is to thrive. When the heads have attained a breadth of two inches the outer leaves should be tied up in order to protect heads against sun and weather and to blanch them. Heads not so protected become green and bitter and are unmarketable. Harvest the heads by cutting as

soon as they are hard and compact. Delay will reduce the quality. Cabbage worms attack this crop. For protection see treatment under cabbage.

Cabbage.—Early cabbage is started in early spring, the plants being set in the garden as soon as soil conditions will permit. Varieties are used which mature early before the hot, dry weather of mid-summer. Quick-maturing varieties are also started in mid-summer to mature in late fall. The last plan is used chiefly in southern regions. Good varieties for early spring or the fall crop are Early Jersey Wakefield, Charleston Wakefield, and Succession.

Late or main-crop cabbage is planted in late spring and grows throughout the summer, the crop being harvested after early frosts in the fall. This type is the one generally stored for winter use. It is also extensively used in the manufacture of sauer kraut. Good late varieties are Late Flat Dutch and Drumhead. Their heads are large and firm, keep well in storage, and the yields are heavy. Two plans of starting late cabbage are practised: The seeds are dropped in hills about two feet apart in rows three feet apart. Very slight covering is necessary. A little powdered lime is placed in each hill to mark the spot when weed fighting begins. The other plan is to start the plants in beds and transplant them when they are large enough.

Cabbage requires much fertilizing and lime is very helpful. On rich bottom lands heavily limed, yields of cabbage reach their maximum. Cultivate often. Rotation of crops is important for the continuous growth of cabbage. Club-root and yellows are both serious diseases. Strains immune from yellows are being developed and seed from these should be secured for use where the disease is prevalent.

Cabbage worms are often very harmful, eating the leaves and boring into the heads. The plants are dusted with powdered arsenate of lead, one part to ten parts of lime dust. This should be applied when the plants are wet with dew. Beginning when the plants are young, make successive applications to protect the new growth.

Kohlrabi resembles cabbage in the form of head. The young leaves resemble cabbage leaves and the two plants are closely related. A solid head resembling a turnip, not apparently made up of layers, is formed a few inches above ground, and the leaves seem to protrude from the sides and top of this.

Turnips are grown both for greens and for the fleshy roots. There are two main types of turnips in common use, the white-

fleshed turnip and the yellow-fleshed, or rutabaga turnip. The latter are sometimes called Swede or Swedish turnips and the former German turnips. Good varieties of white turnips are Purple Top, White Flat Dutch, and White Globe. Because the yields of rutabagas are greater, this crop is more commonly used for livestock, but is also very good for human use. Turnips are extremely hardy, preferring cold weather. As the growth is rapid they may be sown as an early spring crop or as a late fall crop. The seed is commonly sown broadcast, but sometimes in drill rows. A variety called Seven-top is the best for greens. It is often sown in the fall to be harvested in early spring. In regions where there is little or no snow it will usually survive the winter.

Green plant lice attack the leaves of the fall crop much worse than the spring crop, but may be serious on both. The best remedy is to feed the crop to hogs or allow hogs to pasture upon it when the lice appear. Fall turnips and rutabagas are readily stored in cellars free from frost. A little sand in the bins or piles will prevent shrinkage.

Celery seed sown in beds in very early spring will form plants ready to move to the garden in July. This is the best plan for the northern crop. In Michigan celery districts much of the crop is planted in August or early September. Further south seed is started later and the plants are set in garden rows in September. The rows are usually four feet apart and the plants six or seven inches apart in the rows. The crop requires the very richest and finest garden soil. Clean culture must be practised to stimulate growth and keep out all weeds. Nitrogen fertilizers will help stimulate growth. Young plants should be topped when they are about four inches high to make the growth stocky. As winter approaches blanching must begin. (Fig. 196.) Three methods are practised. (1) Soil is banked up against the rows allowing the top leaves to project. (2) Wide boards are set on edge at each side of the rows and the space filled with leaves or straw. (3) Four-inch drain tiles twelve inches long are placed on end around the plants. The leaves can stand considerable frost and harvest should take place just before the heavy freezing of soil threatens to injure the plants. Dig up the plants with roots and place them upright in shallow boxes of wet soil in a dark cellar. This will keep the stems from decaying and will serve as a method of blanching.

Crops that Endure Hot and Cold Weather

Beets.—In the chapter on sugar beets much was given which will guide in the growing of garden beets. Seeds are sown just

after the last hard frost. The plants will endure some light spring frosts, but the seeds germinate better when the soil is fairly warm. Drill the seeds in rows and mix a few radish seeds with them. Thin the rows as the roots become large enough for use. The tops are good for greens and some may be pulled for that purpose if the rows need thinning earlier. Crops may be grown in a succession of plantings so that young beets are fresh until fall. Roots dug in late fall may be stored for a month or more in ordinary cellars. Young beets, however, are commonly canned for winter

Fig. 196.—Blanching celery with heavy black building paper, held close to the plants by wire wickets. (Florida Station.)

use. Good table varieties are Early Eclipse, Early Blood Turnip, and Egyptian. (Chap. XII.)

Carrots seem to be growing in popularity for table use. Good varieties are Early Scarlet Horn, Chantenay, and Half-long Scarlet. The last seems to be the favorite for market purposes. Seeds are usually soaked before planting and then drilled thickly in rows wide enough apart for cultivation. Radish seed should always be scattered in the row to break the crust of soil and to mark the row. An ounce of seed should plant one hundred feet of row. Light soils are preferable. When the roots are large enough to be worth pulling, thinning may begin. Carrots will stand considerable spring frost, but also endure summer heat. Several plantings in succession may be made, to give fresh young carrots for use at all times. The fall crop should be harvested and stored before the heaviest freezes occur, to prevent injury to the crowns. They are sometimes stored in piles outdoors well covered with soil.

Surplus roots are often used for livestock. They are much relished by horses.

Parsnips and Salsify.—These crops endure the summer heat and also the winter cold. Indeed, both seem to be improved by freezing. As neither of these are readily transplanted the seeds are drilled in the open garden rows in very early spring, a few radishes being mixed with them. Soaking the seed before planting will hasten germination. Have the rows well at one side of the garden where they will not be disturbed by succession plantings of other crops. Where the ground freezes too hard for harvesting in mid-winter, enough of the roots should be lifted in late fall to supply the table until spring thaws occur. In regions of open winters these crops are left in the ground until needed. Avoid the use of parsnips after they begin growth the second spring as a poisonous product is apt to form, which injures some people. The second year's growth is for the purpose of seed production. Good varieties of parsnips are Yellow Crown, Guernsey, and Early Round.

Salsify, called vegetable oyster, has a wider range of use than the parsnip because of its seasoning properties. The roots are ready for use in about three months after planting, but they remain palatable throughout the following winter.

Horseradish is grown for relish. The crop is propagated by planting roots the size of the small finger. These readily multiply and are difficult to eradicate. For this reason the plants should be placed in a corner of the garden where they may remain for years. Digging may take place at any time when roots are needed for use or for sale.

Swiss chard is a member of the beet family. Its leaves are large, are similar to sugar beets and have the cooking qualities of spinach. If the crop is planted in the garden in early spring the side leaves may be broken off for use as greens and the plants will continue to produce through the whole summer and until winter freezing of the soil. People who know its merits like it greatly.

Kale or borecole is spoken of as a hardier cabbage as it belongs to the cabbage species. In the milder climates it is commonly grown as a winter crop, being sown in the fall and harvested during open winter weather and in early spring. It is commonly sown broadcast, but may be drilled in rows. It is extensively used as a salad crop and is cooked as greens. When leaves are cut near the crown new growth will spring up giving a continuous harvest so long as cool weather continues.

Collards are similar to kale. The crop endures the hot weather of southern states better than either cabbage or kale, and hence makes a good crop for greens in either cold or hot weather. Seeds are drilled in rows or sown broadcast in fall for the winter crop as for kale and rape. In colder climates the winter growth may be protected with loose leaves or straw. A little freezing seems to improve the quality of the leaves.

Rape or Hanover.—Dwarf Essex rape is the leading variety used in America. In the milder climates it is usually grown as a winter crop, being sown broadcast to supply greens for winter use and for sale in early spring. Farther north the crop is commonly drilled in rows in early spring. Rape is much used for pasturage for sheep, hogs and cattle. Northern growers often sow a crop in August for late fall pasture. When used for human food the crop goes under the name of Hanover in most markets.

Parsley is a relish and garnish for meat dishes and a seasoning for soups. The seeds should be soaked before planting. They are drilled in rows and the plants may be allowed to continue growth throughout the summer, leaves being pulled from the outside of the crown as needed for use. A few plants will supply a family. When winter comes on, transplant a few plants into the coldframe or into window boxes to supply the kitchen throughout the winter.

Endive is grown for salad, the leaves growing in dense, curly heads. When the plants are started in drill rows they should be thinned to one foot apart. They endure transplanting. The flavor of the leaves is bitter unless blanched. This is done by tying the heads of a few plants at a time as with cauliflower. Two or three weeks will blanch them well enough. Rotting may start if the plants are not pulled soon after this.

Onions.—This group is closely related to shallots, leeks, garlic and chives. The main crop of mature onions is extensively sold in the markets during fall and winter. It is produced by sowing seed in early spring in clean, rich soil. Sandy loam which has good drainage is best. A good supply of plant food and organic matter are important. Drill in rows as close together as cultivation methods will allow, about fifteen or eighteen inches. The plants will need thinning to about two inches apart depending on the size of the variety. Wheel hoes are often used in cultivating the crop. Avoid the growth of weeds and maintain a good soil mulch at all times. Tillage should stop as the bulbs approach maturity to avoid a second growth. Harvesting the crop begins as the tops die. In bright, favorable weather the onions may be

left on the surface in the field to cure for several days. Handle onions carefully. Put them in shallow trays or crates to be hauled to market or to storage. A good storage place is a dry attic. Ripe onions are of many varieties, varying in color: Yellow, white, or red. For market purposes use the color demanded.

Green bunch onions are produced chiefly in the following ways: (1) Onion sets or shallot top sets may be planted a few inches apart in rows in the garden. This is usually done early in spring. Shallots may be planted in the fall and will endure considerable winter freezing.

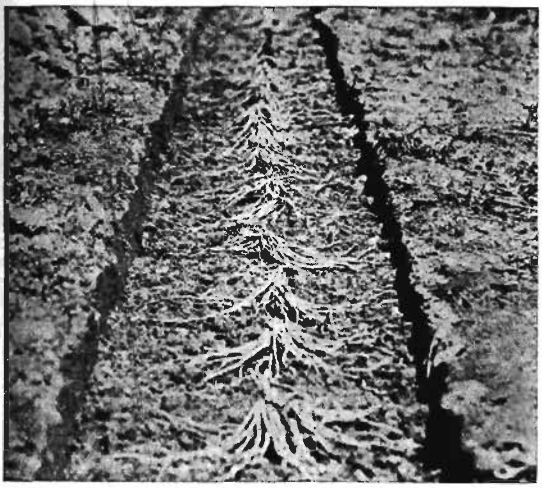


Fig. 197.—Setting asparagus. The trench is well drained and supplied with compost and rich soil. The roots should be spread as shown. (U. S. D. A.)

(2) Seeds of Silver Skin onions or other hardy white varieties are sown in late summer or early fall. The plants are thinned a little if necessary. They will endure considerable winter freezing in the central and southern latitudes. A little mulch of clean straw may be provided where winters are severe. Green onions may be pulled in early spring for use.

Asparagus is a long-lived perennial. Grow it in a part of the garden where it will not be disturbed. It is propagated chiefly by nurseries, and gardeners sell one-year or two-year-old crowns. Plant a variety resistant to rust disease, as Mary Washington. Place these in rows about four feet apart and plant them in the richest compost about ten inches deep with the tops of the crowns six inches below the surface. (Fig. 197.) Put strong plants about two feet apart. Weaker ones may be closer. Do not cover the crowns too deep at first. As they begin to grow add more soil until the trench is filled. Each fall add compost or half-rotted manure a few inches deep over the plants. This may be worked into the soil in early spring before the sprouts start. On large

fields a disk harrow is good for this work. Do not cut the shoots the first two years. After that the crowns should grow stronger and better for many years. Six weeks is a good cutting period each spring. The shoots are cut a few inches below the surface with a round-pointed knife or square-pointed chisel. For market the cuttings are assorted into bunches of equal length nicely tied to make a good appearance in the grocery window.

Rhubarb is another perennial lasting many years. The crop is best in early spring but may be used at almost any time during the growing season. It is usually multiplied by division of roots, but seedlings are sold by nurserymen. Each piece of root planted must bear a bud with its crown. The soil can hardly be too rich. Plant the crowns in trenches covering gradually as the growth begins. With good tillage, plenty of mulching and manuring, the plants should yield for many years.

Globe artichokes are becoming more common in some of the large markets. The undeveloped flower buds are the parts eaten. Start the seeds in hotbeds or indoors in late winter. Transplant these at least once before moving them to the open garden. Set the plants in gardens four feet each way. Strong plants should yield some buds the first year. Yields increase as the plants grow older. Suckers which start each spring from the sides of the plants may be removed and planted in new places. Take a small piece of crown with each sucker. The Globe artichoke is a perennial succeeding for three or four years. It survives the winter in central and southern latitudes, but in the northern states needs to be covered in winter with a furrow of soil and considerable litter.

Warm-Season Crops

Beans are annual plants started in open gardens after all danger of frost is over and when the soil is warm. There are many kinds of low bush beans used as snap beans and many kinds of pole beans used either as snap beans or shell beans, green or ripe.

Lima beans may be either bush (Fig. 198) or climbing in habit. There are three main sizes of the seeds, small, medium, and large. Those with thick, short seeds are called "potato Limas." All Lima beans are shelled from the pods and used, either in the green or the ripe stage. The plants yield best when the seeds are not allowed to mature on the vines. The same is true of all garden crops.

For best success beans should be planted in good, deep, rich soil and should be thoroughly cultivated. The pole varieties require

support. The Kentucky Wonder pole bean and others are often planted with corn for support. Beans are drilled in rows using about one pint of seed to one hundred feet. Where the seasons are long successions of plantings for the bush varieties give a fresh production throughout the season. Beans are tender and are killed by fall frosts.

Table Corn.—Sweet corn and semi-sweet varieties are generally grown for table use. Golden Bantam and Peep-of-Day are extremely early, yielding in forty to sixty days. Country Gentlemen and Hiawatha Sugar come on a little later. Stowell's Ever-

FIG. 198.—Bush lima beans grown as intercrop in young orchard. (New Jersey Station.)

;reen is still later and will continue to yield until frost. The last s not so sweet as the others. Adam's Early has still less sugar, ›ut the ears are larger and many prefer it for that reason.

Low-growing varieties may be planted a little closer than the arge late varieties. The cultivation is the same as that already ;iven for field corn. (Chap. IV.)

Popcorn is often grown in gardens for home use or for market.)o not grow it near other corn because of the danger of cross-›ollination. The cultural methods are in general about the same .s for field corn. The rows may be only two and a half or three eet apart and the stalks may stand about six inches apart in the ows. White varieties will usually sell better than red, yellow, or nottled colors. Rice form of kernels is usually preferred to spiny 'arieties. Harvest the ears as soon as husks show maturity. Dry he ears in a place free from rats and mice. A bin in the attic nay be made mouse proof for this purpose. If spread on the floor

for a few days before it is put in sacks or bins, popping qualities will be improved.

Okra or Gumbo is used as a stewing vegetable and for soups. It is grown more in central and southern latitudes. The seed pods are taken when first formed or before they become fibrous. It thrives only in the hot summer weather and is planted in the garden several weeks after the last spring frosts. A few stalks will supply a small family if the pods are harvested promptly. They continue blossoming and bearing until frost. The plants should stand eight inches or more apart in rows far enough apart to allow cultivation.

Watermelons are grown in home gardens where space will allow. They are grown in large fields for shipment to city markets, the melons being shipped in box cars without crating.

This crop should have loose, sandy soil with a good supply of organic matter and moisture. Rich bottom soils yield well. Different varieties are planted at distances varying from six by six to ten by ten feet. Plant several seeds in each hill and thin the plants to one or two. Use some manure in each hill to stimulate early growth. Clean, horse cultivation should be used between the rows each way until the vines cover the ground. By a little movement of the vines cultivation may continue longer in one direction.

Striped beetles are extremely injurious and can be repelled by dusting with arsenate of lead and lime, as for potato beetles. Dusting with lime and tobacco dust or other repellants is also helpful.

If possible save seeds from melons that have shown good qualities for home use or for market; or select varieties which are most in demand.

Muskmelons and cantaloupes are grown in the open garden, being started from seed sown in hills after all danger of frost is over. Seed should be selected from uniform lots. (Fig. 199.) In northern states the season may require that the crop be started in beds and transplanted. This method may be followed farther south to produce melons for early markets. As transplanting is difficult, seeds are often started in small pasteboard or berry boxes. These are set in the open garden without disturbing the roots. Different varieties require different distances in the garden, being a little less than for watermelons. Late plants are less injured by cutworms than early plants. Cultivation should be deep and thorough and should continue until there is danger of injuring the vines.

Melon rust can best be controlled by spraying with Bordeaux

mixture. Always add some poison to this to help repel the striped beetles. Dusting with arsenate of lead powder mixed with lime is also practised to combat striped beetles. Melon lice (Fig. 200) often attack the crop. Spraying with nicotine sulfate, 1 part to 800 of water, is successfully practised. One person may hold up

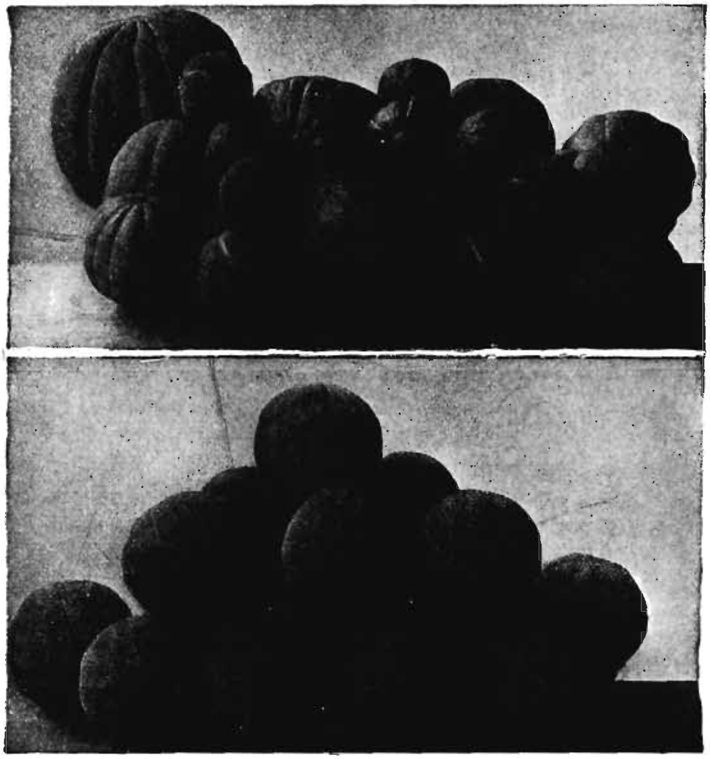


FIG. 199.—Cantaloupes from unselected and selected lots of seeds. Grow a uniform crop of the same variety grown by others of the region. (North Carolina Department of Agriculture.)

the vines while another sprays the under side of the leaves, or a device shown in figure 201 may be used.

Cantaloupes and other small melons are usually sorted by size and marketed in crates, the number being stamped on the outside. They may be shipped long distances.

Cucumbers should not be grown near muskmelons. The two crops are apt to cross-pollinate. The soil should be rich and moist. (Fig. 202.) Some manure should be placed in each of the hills. About ten to fifteen seeds are planted in each hill and slightly

covered. Hills vary from four to eight feet apart, depending on variety and soil. When the vines begin to run, thin each hill to about four or five plants. Continue clean cultivation until the running of the vines prevents. The enemies are about the same as for muskmelons and should be treated as suggested.

Picking should be frequent and thorough. In most cases small

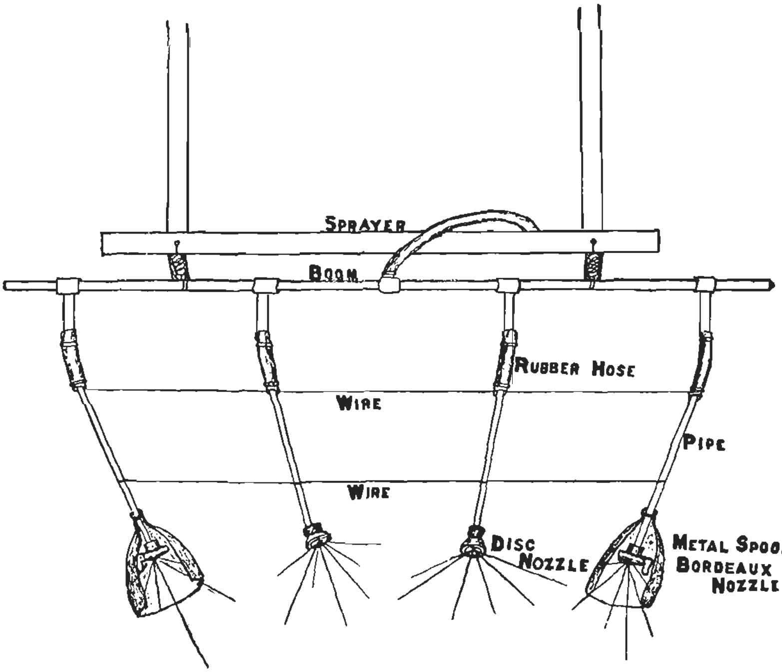


FIG. 200.—Construction and arrangement of floating spars to reach melon lice. The flexibility of the spars and the smooth tin or sheet-iron spoons prevent the nozzles from catching in the vines and tearing them out of the ground. The two middle spars should be shorter than the two outer ones and relatively shorter than shown in the diagram. The force of the spray turns the leaves over, and a second trip in the opposite direction easily hits and wets the aphids with spray. (Ohio Station.)

size is more important than maturity. Yields are greatly increased by frequent picking.

Squashes may be divided into two main types, summer and winter. Summer squashes are probably more popular in southern latitudes and winter squashes in northern latitudes. Summer squashes are used in an immature state and are less highly flavored than the large, mature winter squashes. Plant and cultivate as for cucumbers. The enemies are about the same as on cucumbers, but squash bugs are more serious on squashes. These may be killed

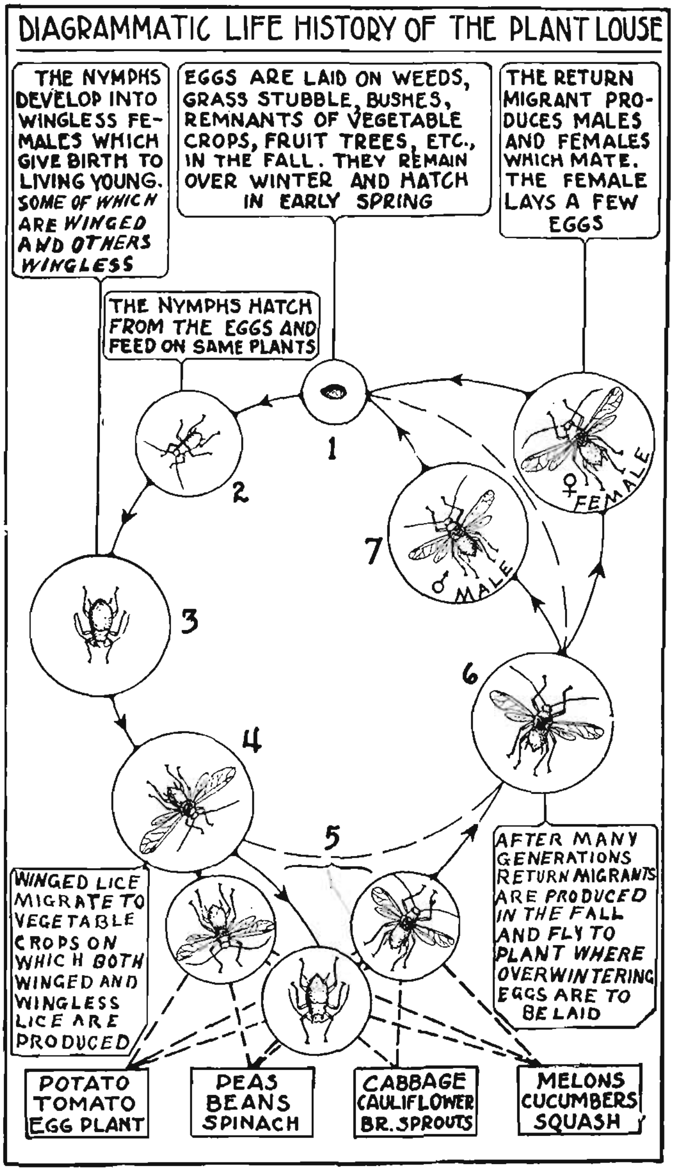


FIG. 201.—Life history of vegetable plant lice. 1, Over-wintering egg; 2, Just hatched stem mother; 3, Matured stem mother; 4, winged migrant on way to vegetable field; 5, Winged and wingless lice on various vegetables; 6, Winged migrant on way to plants where eggs are to be laid; 7, Male and female of the generation which produces the over-wintering egg. These are on the plants where the over-wintering eggs are to be laid. (New Jersey Station.)

Fig. 202.—A Florida field of cucumbers with overhead irrigation. (Florida Station.)

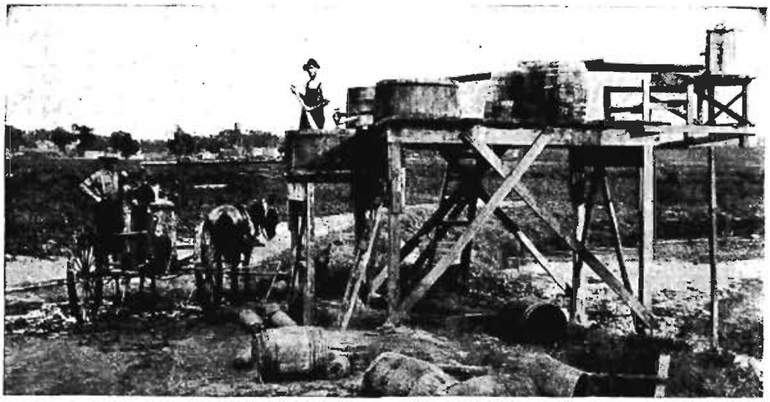


Fig. 203.—Platform and apparatus for preparing Bordeaux mixture in large quantities. The sprayer is here rigged especially for spraying beans. (Cornell Memoir 42.)

by nicotine sulfate or repelled by the dusting for striped beetles. Such winter varieties as Hubbard, White Crookneck, and Boston Marrow, may be kept until mid-winter in a rather dry atmosphere free from frost.

Pumpkins are of two main types, sweet pie pumpkins, chiefly used for human food, and field pumpkins for livestock. But all are used for both purposes. Pumpkins endure shade fairly well and are frequently grown in corn fields, sometimes being planted in the corn rows a little before the last cultivation.

Tomatoes are now more commonly found in home gardens than almost any other garden crop. Seeds of varieties resistant to wilt should be started in hotbeds or window boxes in very early spring. If possible allow two months before time to set them in the garden. Two transplantings are best. Prepare the garden soil well. Secure a cloudy day for transplanting, a week or two after all danger of frosts is over. Water the plants at this time unless the soil is wet. Set the plants in the ground much deeper than they were growing or lay the stems down along the row and cover several inches. This will increase the root surface and prevent suffering in dry weather. They are set in rows about four feet apart with the plants two and a half or three feet apart in the row. There are several ways of staking and supporting tomatoes. A single stake may be driven in the ground to support each plant separately. Tie the vine as it grows taller. Some extensive truck farmers never stake their tomatoes if the soil be rather sandy. If the season is dry this plan suits well. In wet seasons they will suffer more from fruit rot. For very early yields pruning the vines is practised.

Leaf spot and wilt are the worst fungous diseases. Spray with Bordeaux mixture before any leaf spot is discovered. (Fig. 203.) Fusarium wilt attacks the roots and cannot be well controlled by spraying. If the disease has been introduced into the soil grow varieties which have recently been proved to be immune or resistant to this disease. Norton and Norduke are early varieties; Marvel is much later and used for canning.

Peppers are usually started by seeds in hotbeds in very early spring and transplanted to gardens after all danger of frost is over. Practise clean cultivation until the plants are quite large. The fruits are harvested in either the green or ripe form to suit the tastes of users and the demands of the market.

Small hot peppers are grown in much the same way as the sweet peppers, the plants being set somewhat close together in

the garden. The demand is much less than that for sweet peppers.

Egg-plants are also started in hotbeds. They are among the latest of the transplanted crops to be set in the garden. The crop will thrive on good, *rich soil* such as would grow good Irish potatoes. Set the plants two and a half or three feet apart, in rows a little wider. (Fig. 204.) Improved Purple and Black Beauty are popular varieties. Flea beetles, blister beetles and potato beetles are all likely to attack egg-plants. Dusting with arsenate of lead and lime or with tobacco dust are good remedies.

Field Trips, Exercises, Projects, and Problems

1. **Garden Survey.**—As many home gardens have a surplus product to market, the survey may be made to include all types of gardens. Suitable points to include: Areas; lists of crops; most profitable crops; hotbeds and coldframes; transplanting; composts; fertilizers; marketing. Special inquiries should be made regarding the leading market crops of the region.

2. **Problems.**—Make percentage comparisons between the low yields and high yields with leading truck crops; compare costs of production of these crops; compare loss from enemies with cost of fighting these enemies.

FIG. 204.—A field of eggplants in Florida grown for eastern markets. (Florida Station.)

3. **Charts.**—Make a chart showing a list of ten leading garden crops with time of starting and time of harvesting for each; a similar list may be made showing rate of seeding, distances of planting and area needed for a family of five. Make a chart classifying all garden crops into cold-season, warm-season and those which endure both cold and heat.

4. **Debates.**—"Early gardens *vs.* late gardens." "Resolved that fall gardening would pay." "Sweet corn *vs.* tomatoes as a market crop." "Cantaloupes *vs.* watermelons." "Asparagus *vs.* rhubarb." "Onions *vs.* cucumbers."

5. **Field Trips.**—During the times of most active operations make trips to the places of the best growers. There observe and practise as many of the operations as possible, such as thinning, planting, spraying, dusting, harvesting, staking, tying, etc. Visit canneries, pickle factories, kraut factories, driers, packing houses, shipping points and storage houses.

6. **Garden Projects.**—Students should select garden crops for home projects which will probably be most profitable in that section. Outline all steps for the particular crop in full detail. Home gardens including many garden crops may be grown as home projects if careful records are kept of all products used by the family. Profits can be calculated if prices are based upon prevailing market prices each time.

7. **Trials with projects** may be planned which will demonstrate one or more of these points: Superiority of certain varieties; benefits of compost; advantages of earliness; succession planting; companion crops; immunity from disease; methods of fighting enemies.

8. **Exercises.**—Make collection of garden insects for laboratory study. Prepare spray materials as Bordeaux mixture, nicotine solution and kerosene emulsion. Collect and test garden seeds of many kinds. Make germination trials with garden seeds at different depths. Examine samples of garden soils and examine for content of sand, clay and organic matter.

Questions and Investigations

1. To what extent are home gardens grown by local farmers?
2. Describe good garden soils.
3. Give directions for locating a garden.
4. Give directions for planting a home garden.
5. Give the purposes of hotbeds and coldframes and directions for making.
6. Classify garden crops into three seasonal groups.
7. Which should be started in hotbeds?
8. Give the management of a hotbed and its crops.
9. Give directions for preparing garden soils.
10. What is a compost?
11. Discuss fertilizers for gardens.
12. Give suggestions for transplanting to the garden.
13. Give general rules for seed planting.
14. Discuss the growth of spinach and New Zealand spinach.
15. Compare the culture of mustard and turnips. Of radishes and lettuce.
16. Discuss the growing of garden peas.
17. Compare the culture of cauliflower and cabbage.
18. Outline the steps in the growing of celery.
19. Compare the culture of beets and carrots; of parsnips and salsify.
20. What are the advantages of Swiss chard over other greens?
21. Where would you grow horse radish plants?
22. Compare kale, collards, and rape.
23. How would you grow parsley? Endive?
24. Describe onion culture.
25. Give directions for success with asparagus; with rhubarb.
26. Why plant snap beans successively?
27. Mention the types of Lima beans and tell when and how to plant.
28. Mention early, medium, and late varieties of table corn for your region.
29. Which would you plant in succession?
30. Give directions for success with watermelons; with muskmelons.
31. Compare the culture of cucumbers, squashes and pumpkins.

32. Give full directions for growing tomatoes. Include your own observations.
33. Compare the growing of hot and sweet peppers and egg plant.

Farm Mechanics.—Make flats for plants; line reel; wooden dibble; stakes; markers; crates; trays; planters; hotbed frames. Repair hotbed covers, planters, cultivators, hand tools.

Calculations.—1. By using a wilt-resistant strain of tomatoes a grower doubles his crop. The yields for non-resistant tomatoes averaged 160 bu. per acre. The crop sold at an average of $1.30 a bu. for the first half and 85¢ for the last half. Find the income per acre for each type.

2. A grower started 1,210 cantaloup plants in bands and frames, which added a cost of $20. By this early start he received an average of $2.50 per crate for the first half and $1.50 for the second half. His total yield was 224 crates. Find his profit due to earliness if other crops averaged $1.40 per crate.

CHAPTER XIX

IMPROVEMENT PROJECTS

THE convenience and appearance of the home place should be of interest to high school students and others. Projects of a comprehensive nature for beautifying and improving the premises, or a definite program of betterment may be profitably undertaken. There are general phases of home improvement from which improvement projects for a particular place may be planned: (1) Putting in order the existing place; cleaning and picking up trash; restoring objects to their proper places; caring for roads and lawns; destroying weeds; pruning trees and shrubbery. (2) Studying the present situation which may suggest replanning or adding new features; location of paths and drives; location of facilities such as wood piles, ash heaps, garbage disposal, clothes lines, chicken coops, corn cribs, out-houses, coldframes, scales, barn doors, wagon sheds, standing room for vehicles, and turnarounds; relationship between areas such as those occupied by house, barn, garden, orchard, chicken yard, and barnyard; amount, location and desirability of lawn, trees, shrubbery, vines and flowers; condition, appearance, and convenience of buildings. (3) The carrying out of the proposed improvements; repair of buildings and fences, painting and whitewashing, fixing leaky roofs; laying out of drives and walks. (4) Planting trees for background, and shade around buildings, as wind-breaks and shade along roads; planting of shubbery and vines to beautify certain spots, separate different parts of the grounds, or hide unsightly buildings; planting of flowers (usually in a garden or in borders). (5) Installing modern conveniences, running water, bathroom equipment, septic tank, and electric lights, and irrigation. (Fig. 206.) See job analysis p. 318.

The beneficial results of such improvements are included under some of the following heads: (1) For the members of the family—better satisfaction with home surroundings, improvement and conservation of health, a valuable education for its younger members. (2) For the community—good example. (3) For the place itself—enhanced value.

Basis for Calculating Profits.—When beautifying and improvement projects are undertaken by young people the financial profits may be calculated in one of several ways: (1) A disinterested committee may be appointed to examine and appraise at the

beginning and at the close of the project. (2) A liberal allowance for time actually used in the pursuit of the project may be made the basis for determining the profits. (3) Sometimes offers for the place before and after improvement may be used to demonstrate the benefits derived from the improvement project.

Replanning.—In replanning the home grounds there are four points to be considered: (1) Circulation; (2) area; (3) exposure; (4) view. The problem of *circulation* considers walks and drives, their necessity and distance. It is closely connected with the problem of *area*, which concerns number, size and location of the various units that make up the place. For example, the dis-

FIG. 205.—The residence among the trees is on higher ground than the barns. Buildings and fences all painted and kept in repair. (U. S. D. A.)

tance from the garden to the kitchen is an important one to the housewife. Again, the garage (another unit) may be poorly located and require an unnecessary amount of road, or roads may be so arranged that they run entirely around the house allowing no lawn or out-door living space near the house.

Exposure considers the relation of the buildings and other areas to the sun and wind. (Fig. 205.) It is usually too late to make a great change in this regard, but planting may serve as a windbreak or protect from the hot sun, and gardens and even arrangement of rooms in the house may be shifted for a more desirable exposure.

View is largely the result of planting arrangement; it may leave an opening or vista to allow the enjoyment of beautiful scenery; it may be an open lawn space in front of the house. On the other hand, it may be creating a sense of privacy by definitely enclosing an area like the clothes yard or croquet lawn, cutting off and screening unsightly surroundings, or simply giving a back-

ground to otherwise isolated buildings. Planting a tree behind a hen house is often as important as planting shrubbery in front of it.

Directions for Planting.—Trees and shrubs should not be scattered promiscuously over the surface of the lawn. They should be planted with a definite scheme in mind. Trees should be planted where they will give proper background, frame attractive views, and shade walks, roads, and buildings. Do not try to shade the entire surface of the lawn with trees. The best authorities on landscape gardening recommend planting shrubbery in masses. It may be used around foundations, along the edges of yards, in corners, at the angles of walks and sometimes at the curves in roads. Tall shrubbery will give a feeling of privacy and screen undesirable

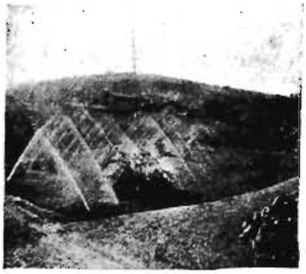


Fig. 206.—An abundant supply of water adds to the possibilities of beautification. (Skinner Irrigation Company.)

Fig. 207.—A pond in early spring. Quiet water adds charm to the landscape. (F. A. Waugh, Massachusetts Agricultural College.)

surroundings. Low shrubbery is chiefly for embellishment. Thorny shrubs such as dwarf barberry, and Japanese rose, take the place of fences or require people to follow walks instead of cutting across lawns. Leave a beautiful greensward to be mowed and give a neat appearance to the place. (Figs. 209 and 207.)

Vines are used to break the monotony of bare walls and soften the hard lines of projecting corners. Vines on trellises will hide unsightly buildings or obscure the view of bare lots or gardens. Vines should be selected to suit their particular purpose. For pergolas, arbors, wooden or wire trellises, use such vines as clematis, grapes, climbing roses, wisteria, Virginia creeper, Madeira and certain annual vines, such as Japanese bean, morning glory, cyprus vine, gourd, and prickly cucumber. On fences or buildings of cement, brick or stone, use Boston ivy, English ivy and Englemann's ivy. These would also be good on old tree trunks or stumps. English ivy is evergreen and grows slowly. The others make much more rapid growth, but lose their leaves in winter.

Selection of Trees.—The planting of trees is an important part of improvement projects. It is desirable to plant trees with the idea of permanence, but for quick results plant cottonwood, poplar, soft maple, and willow. A few trees that are less temporary and that give fairly quick results are black walnut, butternut, hardy catalpa, and true mulberry. Trees that are slower in growth and live for many years are American elm, sugar maple, basswood, oaks, and ash. Good evergreens are Norway spruce, white spruce, white pine, Austrian pine, Scotch pine, arbor vitæ, and hemlock.

Hedge Plants.—There are hedge plants suitable for various situations. *California privet* is adapted to the central states and as far north as New York. *Amoor* or *Chinese privet* is evergreen in the southern states and nearly so as far north as the Ohio river. Its leaves are finer and the effect better than when California privet is used. *Japanese barberry* is suited to all regions except the drier climates. After the leaves fall the hedge shows a fine display of red berries which attract winter birds. *Japanese quince* is a beautiful flowering hedge in the northern states, but is severely attacked by scale insects and must be sprayed each winter. *Osage orange* thrives fairly well in all states, even in the drier states as far west as Nebraska. It must be pruned severely to produce good effects. *Arbor vitæ* may be used as an evergreen hedge and trimmed to any height desired. *Trifoliate orange* forms a beautiful thorny hedge, suited to the South Atlantic and Gulf states.

All hedge plants require considerable attention and constant pruning throughout the growing season to attain the effects desired. Other plants often used for hedges are box-wood, certain roses, and spruces.

Perennial flowering plants are best located in borders or in front of shrubbery plantings. Have a bed of them six or eight feet wide along the side of the garden next to the lawn. Careful study should be given to the arrangement and the selection of varieties. Color schemes, heights, season of flowering and all other plans may be worked out to suit the owner and give pleasing effects. Nursery catalogues will greatly aid in working out the final design. Most perennials are readily propagated by root division and supplies of roots may often be obtained from old plantations of relatives or friends who want their beds renewed by digging and division of plants. A good time for doing this work is in the fall, while the old flower stalks are still standing and the roots can be readily located. Prepare the bed by digging the soil deeply and supplying plenty of rotted compost.

The Planting of Flowers. Dates are for Latitude of New York. (Cornell Reading-course Leaflet)

Name of flower	Amount of seed for 10 ft. of row	Time to plant: Hotbed	Time to plant: Open ground	Distance apart (inches): Between rows	Distance apart (inches): Between plants in row	Depth to plant seed (inches)	Hardy, half-hardy, or tender	Height to which plants grow (feet)	Annual—A Biennial—B Perennial—P	Season of blooming
Ageratum	1 pkg.	March	May	12	6	¼ to ½	Hardy	½ to ¾	A	June to frost
Alyssum	1 pkg.		May	12	6	¼ to ½	Hardy	¼ to ½	A	June to frost
Antirrhinum	1 pkg.	March	May	12	12	¼ to ½	Hardy	1 to 3	P	July to frost
Aster	1 pkg.	March	May	12	9 to 12	½ to ¾	Hardy	1 to 3	A, P	July to Oct.
Balsam	1 pkg.	April	May	24	24	½ to ¾	Tender	2 to 2½	A	July to frost
Calendula	1 pkg.	April	May	12	6	¼ to ½	Hardy	⅔ to 1	A	June to Oct.
Campanula	1 pkg.	March	April or May	12 to 18	12	¼ to ½	Hardy	2 to 3	A, P	June to Aug.
Candytuft	1 pkg.	April	May	12	4 to 6	¼ to ½	Half-hardy	½ to ⅝	A	June to Oct.
Centaurea	1 pkg.	April	May	18	6	¼ to ½	Hardy	2 to 3	A	June to frost
Chrysanthemum	1 pkg.	March	May	12 to 18	8	½	Hardy	1 to 4	A	June to Oct.
Cockscomb, low	1 pkg.	April	May	18	12	¼ to ½	Hardy	1 to 1½	A	June to frost
Cockscomb, tall	1 pkg.	April	May	24	24	¼ to ½	Hardy	3	A	June to frost
Convolvulus (morning-glory)	1 pkg.		April	To climb on some support	6	½ to ¾	Hardy	10 to 15	A	June to frost
Coreopsis	1 pkg.	March	April	18	10	½	Hardy	1½ to 2	A, P	June to frost
Cosmos	1 pkg.	April	May	24 to 30	24	½	Hardy	4 to 8	A	July on*
Dahlia	1 pkg.	March	May	12 to 18	6	½	Half-hardy	4	P	Aug. to frost
Dianthus	1 pkg.	March	May 1-10	12 to 18	6	¼ to ½	Half-hardy to hardy	1 to 1¼	A, P	July to frost
Hollyhock	1 pkg.	March	July to Sept.	24 to 36	15	½	Hardy	5 to 7	P	Aug. on
Larkspur	1 pkg.	March	May	12	12	¼ to ½	Hardy	1 to 5	A, P	June to Sept.
Marigold	1 pkg.	April	May	12	6	¼ to ½	Tender to half-hardy	½ to 2	A	July to frost
Mignonette	1 pkg.	March	May	12	12	¼ to ½	Tender to half-hardy	1 to 1½	A	July to frost
Nasturtium	1 pkg.	April	May	12	12	½ to ¾	Half-hardy	¾ to 1	A	June to frost
Pansy	1 pkg.	March	April	12	6	¼ to ½	Hardy	⅓	A	April to frost
Petunia	1 pkg.	Feb. or Mar.	May	12	12	¼	Hardy	1	A	June to frost
Phlox (annual)	1 pkg.	March	May	18	12	¼ to ½	Hardy	1	A	June to frost
Poppy	1 pkg.		Ap., Sep., Oct.	12	12	¼	Hardy	1 to 2	A, P	June to Aug.
Salvia	1 pkg.	March	May	24	18	¼ to ½	Half-hardy—P to hardy—A	2 to 3	A, P	Aug. to frost
Stock	1 pkg.	March	May	18	12	¼ to ½	Hardy	1 to 1½	A, B	July to Sept.
Sunflower	1 pkg.	April	May	36 to 60	24 or more	1	Hardy	6 to 10	A	Aug. to frost
Sweet peas	2 pkgs.		April	36 to 48	Thick	1 to 1½	Very hardy	2 to 6	A	July to Sept.
Sweet William	1 pkg.	March	June	12	6	¼ to ½	Hardy	1½ to 2	A, P	June, July

* Early, July to August. Late, September to October.

Early flowering perennials are here given somewhat in order of their blossoming dates: Anemone, bloodroot, rock-cress, spring beauty, hepatica, wake-robins, shooting star, candytuft, forget-me-not, peony, the smaller phloxes, columbine, lily-of-the-valley, bleeding-heart, iris, violets, and pansies.

Summer and Autumn Perennials.—Tall anemone, blue columbine, mallow, harebell, Canterbury bell, Scotch pink, Japan iris, blazing star, oriental poppy, perennial phlox, yucca, hollyhock, day lily, flame flower, cardinal flower, coreopsis, hardy chrysanthemum, golden glow, golden rod, and Jerusalem artichoke.

Annual Flower Border.—A similar border of annual flowers will give much beauty and delight if well planned and given proper care. Tender annuals are usually sown in the spring and will die down when fall frosts occur. Examples of this group are balloon vine, balsam, cosmos, cockscomb, cobæa, calladium (bulbs), castor bean, dahlia, gourds, martynia, nasturtium, petunia, sensitive plant, verbena.

A few of the hardy annual flowers may be sown in the fall, transplanted to boxes or coldframes for the winter and set in the garden in the spring. This plan gives earlier blossoms than when the seeds are sown out-doors. In mild climates plants started in the garden in the fall may be protected by litter or mulches. The latter plan often succeeds whether a certain flower be annual or perennial. Some that seem to be perennial in southern latitudes are true annuals farther north. In the central states the following are used as hardy annual flowers: Ageratum, aster, calendula, calliopsis, California poppy, candytuft, larkspur, gilia, morning-glory, marigold, mignonette, phlox, pinks, portulaca, sweet alyssum, sweet pea, stocks, and zinnia.

Native Plants.—In improving home grounds by the use of trees, shrubs and flowers (Fig. 208), do not make the mistake of searching for rare plants, but learn to appreciate the beauties of the simple, everyday, hardy sorts that may be depended upon. Frequently these grow wild in your own woods and hedges. The sumacs, arrow-woods, elder, buck-bush, wild roses, trumpet-creeper and many others can be introduced into your growing plans. The trees native to your own region and growing most commonly are very likely to be the ones that will give the best service. In Europe native asters and goldenrods are cultivated very carefully by gardeners, although with us they are commonly classed as weeds, owing to the difficulty of their control, but native ferns, cardinal flowers, turtle-heads, butterfly weed, boneset and most of the spring

flowers are suitable for the flower border. The best landscape gardeners in America have been those who thoroughly understood the beauties and use of our common native plants and many of their tricks of artistic arrangement they have learned from observation of nature.

Lawns.—Nothing will help the appearance of a place more than a good lawn. (Fig. 209.) Have the soil well prepared and nicely graded before sowing. Select the grass that suits your

Fig. 208.—*An attractive yard, beautified by masses of shrubbery and a fish pool with water plants.* (Photo by Rex Troup.)

region best. In moist, cold climates use Kentucky blue-grass with a little white clover. In the Gulf states and south Atlantic region Bermuda grass and carpet grass are used. In the dry regions of the Dakotas and southward, use smooth brome grass. Sow at any time when there is plenty of moisture, as after fall rains begin or in early spring. Most grasses are helped by lime and fertilizers.

Care of Lawn.—(1) Add nitrate of soda whenever the growth seems stunted. (2) Reseed any bare spots or thin spots whenever found. (3) Apply more lime every few years. (4) Apply a top dressing of well-rotted manure in early winter over the entire surface. The fertilizer is washed into the soil by winter snows and rains and the crowns are protected by the manure. The litter should be raked off as growth begins the next spring. (5) Keep the lawn well trimmed, preferably with a lawn mower. Forming seed is injurious to grasses. Mowing induces sod forming. Mowing is detrimental to weeds and beneficial to grasses. (6) Roll lawns

in the spring, if winter freezing has heaved the crowns out. In severe cases this may be prevented by the addition of fertilizer and a thin layer of rotted compost to help the crowns. Rolling or pounding helps the rootstocks and runners to become well rooted.

Roads and walks need not be expensive. Lay them out only where they are needed. If walks and roads are rather long, a little curvature adds grace and beauty, but do not fall into the error of making curves that are dangerous on account of automobiles.

FIG. 209.—A beautiful side yard with greensward and mixed border at a *farm home.*

Short walks and roads should usually be straight. The surface of the road itself may be of cinders, gravel, macadam (oiled or bituminous), or concrete, according to the kind of use, and the funds available.

Walks should be built of durable materials, which are convenient and pleasant to walk upon. Gravel or cinder walks are inexpensive. Board walks are temporary and costly in the long run. Flagstones if laid closely and evenly will last for a very long time and frequently give very pleasing effects. Stepping stones about eighteen inches apart, except for very short distances, should be avoided. They are used when dry trails through otherwise wet grass are needed. For ordinary purposes the best walks are made of concrete. Expense in making concrete walks may be saved by reducing the width and occasionally the thickness. Have a good foundation of cinders, sand and gravel. Never try to reduce expense by making a poor mixture of concrete. Rich mixtures will pay better in the long run. One of cement to three of sand and gravel will make a good walk. The surface may be one to two.

Permanent Road Construction.—Young people should understand the principles of constructing good roads. The annual cost of repairing expensive highways has led to much study of road construction since the advent of pleasure cars and motor trucks. The main principles to be borne in mind in the construction of the most durable roads are given: (1) Perfect drainage of the foundation, and of the surface so that water will not stand to soften the bed nor to puddle the wearing surface. (2) Easy grades and large, sweeping curves. (3) Heavy foundations to prevent sinking in the softer spots and to prevent "waves" in the surface when heavy loads are hauled. (4) Good binding material in the body of the road to prevent ravelling and "break down" during use. (5) A hard wearing surface to endure the wear of iron wheels for long periods. (6) Water-proof surface to prevent the entrance of rain water which would start puddles, ruts or ravelling spots.

Perfect Drainage.—The time to plan the perfect drainage of a road is when it is first laid out even before construction begins. Ditches or drains at each side should entirely carry away the water

FIG. 210 a.—Showing proper curvature of finished roadway so as to insure good drainage.

from the road and conduct it to natural or other outlets. Figure 210a shows a good form of crown for the subgrade. The shoulders are left as shown to hold road materials.

Foundation.—Some of the federal roads recently constructed have foundations of hard rock eight inches long laid on end. Telford roads have foundation stones laid by hand on the road bed. Macadam roads have the bottom layer of three or four inches of crushed rock, rolled in place while wet. Some modern roads have a layer of concrete several inches thick on the subgrade as a foundation for the road material which distributes the load evenly over the foundation.

Rock Materials for Roads.—Telford and the various forms of macadam are thus far the most common among the durable roads. The ancient Roman roads similar to these are still serviceable. The rock used should itself be very hard. The harder forms of limestone are used in many parts of the United States.

After the first coarse layer of crushed rock used in macadam construction has been wet and rolled in place, a layer of smaller rock two to three inches in diameter is spread evenly, wet, and

rolled. The smallest crushed rock is filled with binding material, which is wet and rolled several times. This *binding material* may be limestone dust.

As the surface of the old macadam roads yielded somewhat to the wear of iron tires the road surfaces required constant repair. This consisted of scarifying the surface, slightly leveling it and rolling. To harden the surface and make it more water-proof recent road builders have oiled the surface by spreading thick, crude oil direct from the oil wells or composed of distillates of such oil, applied when the road is dry, followed by spreading sand and

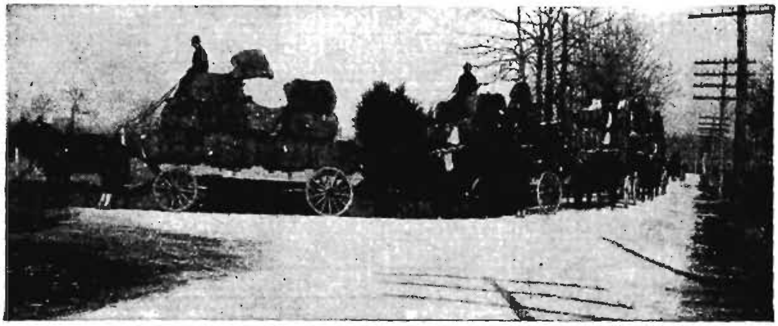


FIG. 210 b.—Ten or more bales of cotton may be drawn to market over the improved roads. All the cotton can be marketed while the price is at its best. Thus the road pays its cost. (U. S. D. A.)

gravel over the surface, and rolling it in with heavy rollers. Such roads shed water well and have a much more durable wearing surface. (Fig. 210b.)

Bituminous Macadam Roads.—In making the stone roads already described water is used to aid in cementing the particles together particularly when rolling in the fine binding material. In bituminous stone roads some form of tar is used in place of water in the top layers.

Tarvia is a well-known form of tar-bound road made by rolling the top layer of rock while dry and spreading hot tar over it until the entire surface is covered; then the binding dust is spread on top and thoroughly rolled.

Bitulithic roads require more labor as the top layer of crushed rock is mixed with tar or similar material while hot in vats or kettles. This is evenly spread while hot and rolled in place; then the top dust is spread on and rolled.

A slight variation from either of these plans is to also mix the top dust lightly with tar or asphalt in a dry enough condition

to be spread evenly and rolled while hot. This makes the surface still more impervious to water.

Concrete Roads.—A number of state highway commissions have built hundreds of miles of concrete road. These are believed to be very durable. In some cases a surface layer of oil, sand and gravel is used over the concrete as a protection and to lessen the wear and prevent dust. Brick roads are used in sections where suitable brick clay is the cheapest available material and traffic is heavy.

Sand-clay roads are much used in states where funds are not available for more permanent roads. They are very satisfactory when kept in good condition. Heavy road drags drawn by trucks or tractors are used to regrade the surface after rainy weather.

Dirt roads, for many years to come, will constitute the largest mileage in America. They should be kept well surfaced and

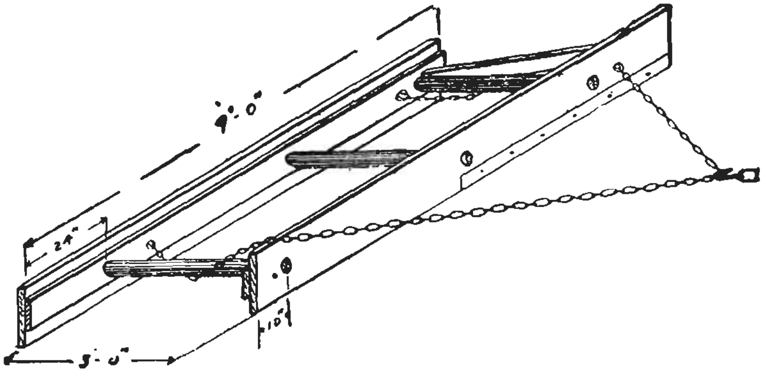


FIG. 211.—This drag is made from two pieces of ten or twelve inch plank, two or three inches thick and eight or nine feet long, reinforced by a two-inch by six-inch strip. The cross braces are four-inch sticks shaped to fit a two-inch hole. A board platform, not shown in the cut, is laid on the cross pieces for the driver to stand upon. (U. S. D. A.)

crowned by the use of road drags. The cost of dragging is little and the results are surprising. (Fig. 211.)

A home-made septic tank will destroy all waste materials entering it from the bathroom and kitchen through a drain pipe. Bacteria action in the tank reduces all organic compounds to water and other elemental forms. The principles involved in its proper construction and action are given: (1) The tank should be underground and dark. (2) It should have very little, if any, ventilation. (3) It should not leak but should stay full of water at all times. (4) The outlet should be at a lower level than the inlet and on the opposite side. (5) The inflow should enter against a

baffle board or an elbow to prevent sudden agitation of the surface scum where bacteria are at work. (6) The outflow should be through an elbow or T-joint so that the surface will not be drained off through the outlet pipe. (7) A cross partition dividing the septic tank into two compartments should be used when more than one household is using the tank, and for schools. When so built the partition should have a number of openings through it two or three feet below the surface of the liquid. (8) A tank of about 500 cubic feet of space should be provided for a family of eight persons. (9) Use four-inch inflow pipe. (10) Use four-inch outlet pipe, running to lower ground or to a pit filled with waste, rocks, brickbats or other debris.

No odor will be detected about a septic tank when properly constructed and the outflow liquid is nearly pure and may be used in watering flower beds or gardens if the outflow pipe leads there.

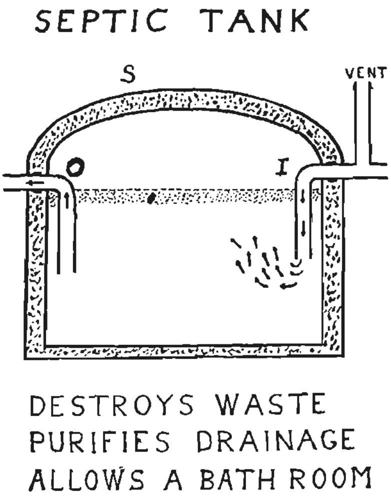


FIG. 212.—A septic tank will destroy all wastes from the kitchen sink and bathroom drain and allow only clear water to pass on. It is a hole in the earth walled with concrete or other water-proof material. The inlet, I, ends with an elbow extending below the surface to prevent agitation. A vent reaching above the soil surface, S, will allow surplus gas to escape from inflow pipe. The outlet pipe, O, also has an elbow to prevent the outflow of the surface scum where the bacteria are rapidly decomposing the wastes. Copy for a chart.

Construction of Septic Tank.—Figure 212 shows the vertical section and general construction of a septic tank for one family. In soils that are rather firm or contain some clay, it is best to allow the earth to stand as the outside form in pouring the concrete wall. Dig a cylindrical hole six feet deep and seven feet in diameter. Take boards of any length and stand them on end six inches from the bank to constitute the inner form. The lower ends may be driven into the bottom soil to hold them in place. Soak strips one-half inch thick and two inches wide in water over night. Bend these around the inside of the barrel-like wooden form and nail them lightly to the upright boards.

Mix concrete either on the floor of the tank or on a mixing board at one side. Use one bag of cement to three bags of sand

and two of gravel. When thoroughly mixed and properly wet, shovel this into the form. If plenty of surface stones are available use many of these by dropping them between the forms into the mortar. For reinforcement, gather up any waste wire about the place and lay it in the wall form as the mortar is being poured, going round and round until the form is filled with concrete. Use a scuffle hoe or flat spade to paddle the surface next to the boards inside the form while filling. When the concrete has set, the

FIG. 213.—A good arrangement for a corn booth. (Florida Station.)

wooden frame may be torn away and the surface plastered with a rich mixture of one-to-two concrete. Also pour the floor at this time. When this coat hardens use a gallon of gas tar and paint the entire inside with one or two coats to prevent leakage.

Provide openings for the inlet and outlet pipes through the walls when pouring them. The pipes should now be put in place and the surrounding space filled with concrete. The top of the tank may be made of double planking, or a form may be built and a reinforced concrete top may be poured.

The Rural Community.—Recent years have been marked by a rapid growth in rural community organization. Community clubs of many kinds have been formed. These are often local units of a county farm bureau or other organization. Boys' and girls'

clubs (Fig. 213), women's or mothers' clubs, parent associations, community circles and other names are given to associations, according to improvements or objects in view.

Types of Improvement.—The united endeavors of such associations follow special objects of their own and may include allied activities such as the following: (1) Improvement of educational facilities. (2) Social betterment of young people and others. (3) Church unity and religious advantages. (4) Better roads and means of transportation. (5) Telephone service. (6) Mail service. (7) Coöperative packing and grading of products. (8) Coöperative marketing. (9) Coöperative production, as breeding clubs, poultry clubs and fruit clubs. (10) Coöperative manufacturing, as canning, pickling and drying, cheese and butter making, kraut making, sausage making, meat curing, and tanning. (11) Coöperative refrigeration and storing. (12) Improvement of rural health and sanitary surroundings. (13) Civic improvement and study clubs. (14) Beautifying of the community, homes, public and school grounds, roadsides, parks and playgrounds. (15) Country planning.

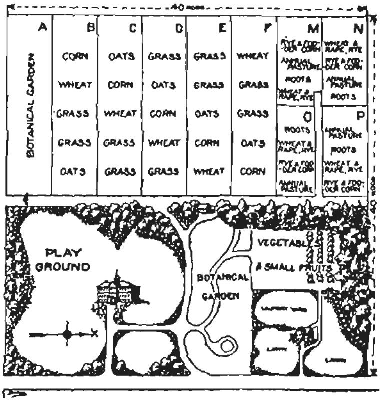


Fig. 214.—Plan for a school grounds, teacher's home (at right), and the school land laboratory (upper half). (U. S. D. A.)

School improvements often come first in community endeavors. They include such objects as these: (1) More months of school. (2) Consolidation in some cases. (3) Additional rooms. (4) Physical improvements such as gutter, paint, black-boards. (5) Walks. (6) Fences. (7) Pure water and sanitary drinking facilities. (8) Sanitary toilets or septic tanks. (9) Interior improvements, pictures, libraries, paint. (9) Flag and pole. (10) Better teachers with better pay. (11) Better school spirit and better attendance. (12) Replanning of school grounds. (Fig. 214.)

Individual Effort in Community Endeavor.—To be successful in any community work the individuals, or some of them, must take a lead in the right direction. So long as those looked upon as leaders remain indifferent, nothing will be accomplished. Teachers, members of school boards, justices and squires are often considered as leaders but fail to assume leadership. They, as well

as others, often shirk the duty of leadership. Membership in any community, whether organized or not, is a responsibility which no one should shirk. Educational advantage, property ownership, residential location and other favorable circumstances add to the responsibility.

The community spirit is better where all are willing and anxious to do their parts. Many would become good leaders if they would lay aside personal feelings and forget their old differences. They should never hold fast to personal or family grudges. Community activities during the World War developed many good leaders who should continue their good work and set examples for others.

Surveys, Trips, Projects, Problems, and Exercises

1. **Improvement Survey.**—In making a local survey concerning improvements include such points as those given on the first page of this chapter.

2. **Problems.**—Calculate the probable cost for each of the lines of improvement, taking the same or a different place for each. Estimate the proper increase in value of the farm if a buyer should be inspecting the place after the improvement is made.

3. **Projects.**—Some students should plan definite projects along lines of improvement and beautification including any or all of those suggested at the beginning of this chapter. Decide at the outset what improvements are to be made during the pursuit of the project. Let the work continue through a year, more or less, as conditions may require.

4. **Trips.**—Students may take trips together or singly to inspect projects of this nature; places where water supply is being installed, where plumbing fixtures are being planned or installed. If septic tanks or hot-water tanks are being installed, visit the place and assist in the work. Visit other places already completed which are known for their attractiveness and convenience.

5. **Exercises.**—(1) Dig shrubs and vines and study their means of multiplying under ground. (2) Study methods by which vines climb. (3) Make cuttings of shrubs and vines and plant them, using privet, grape, barberry, spirea, syringa, deutzia, snowball, rose, weigelia, Boston ivy, Virginia creeper. (4) Multiply winter shrubs and plants by root division. (5) Replan on paper poorly arranged premises. (6) Make drawings of water systems for your home or others in the neighborhood: gravity from springs; kitchen pumps from wells and cisterns; hydraulic rams; overhead tank systems; underground air-pressure tank systems.

Questions and Investigations

1. Mention a number of ways in which your place or neighbors' places may be improved.
2. What are the benefits of such improvement?
3. Give directions for locating shrubbery.
4. Discuss uses of vines.
5. What kinds of shade trees would best suit your region?
6. List hedge plants you would use.
7. Suggest plans for a perennial flower bed. Name such flowers.
8. List good annual flowering plants. Which are most hardy?

9. Give important features in care of lawns.
10. Mention plans for the improvement of walks.
11. List native trees, shrubs, vines and flowers worth transplanting.
12. Give six essentials in good road construction.
13. Describe road foundations.
14. Compare macadam and Telford roads.
15. Compare tarvia with bitulithic roads.
16. Mention advantages and disadvantages of concrete roads.
17. Give the principles for constructing a septic tank.
18. Give directions for construction.
19. What improvements have been made by clubs in your region?

Analysis into Jobs.—Farm improvements may include the things mentioned in Chapters III, XIX, and XXVIII. The seven jobs are suitable for most of these forms of improvement. References are to the chapters mentioned and also to Davis' *Farm Projects and Problems*, Chapter XVII. See also *U. S. Farmers' Bulletins* and books listed below.

1. Deciding to improve the farm and in what ways.
2. Making plans for the improvements.
3. Listing materials; estimating costs.
4. Laying out the plans on the place.
5. Selecting and procuring materials.
6. Executing the plans.
7. Realizing on the improvements.

References.—U. S. Farmers' Bulletins: 1227, Farm sewerage; 750, Roses; 1171, Annual flowering plants; 1234, Gullies; 1132, Planning the farmstead; 1173, Community buildings; 1087, Beautifying the farmstead; 1166, Poison ivy; 181, Pruning; 1209, Planting trees; 1426, Farm plumbing; 1448, Water supply; 1452, Painting; 1677, Lawns.

Farm Mechanics.—Make plant trellises; road drag; play-ground apparatus, as swings, teeter boards; build walks; make roads; paint buildings and fences; repair windows; roofs; roads; gates; fences; pumps; install water supply; sanitary devices.

Calculations.—1. A man bought a rundown farm of 160 acres at $40 an acre, paying $2,000 cash and giving notes at 6 per cent per annum for the balance. At the end of 18 mo. he had added $540 in improvements to the premises, conveniences, and soil. He then sold the farm for $66 an acre. Find his net profit.

2. A family added a number of home conveniences for health reasons and believed they saved $170 a year in doctor's bills. The septic tank and connections cost $22 for materials; the bath-room fixtures and materials cost $110; water supply materials cost $33. If they did their own labor find their profit or loss for one year; for 10 years.

WOODLAND PROJECTS

Analysis into Jobs.—The teaching units in a woodland enterprise may be considered under the following seven jobs. References are to pages in *New Agriculture*, Davis' *Farm Projects and Problems*, and to numbers of *U. S. Farmers' Bulletins.*

1. **Deciding whether or not to pursue a woodland project, and the purpose**, pp. 319, 322; *Farm Projects*, 326–328; *Bulletins*, 622, 1071, 1117, 1405, 1486, 1603, 1664, 1680. *Local inquiry.*—(*a*) Talk with lumbermen and others regarding changes in prices of posts, poles, ties, lumber, etc., in recent years. (*b*) How many local farmers have a suitable place for a farm woodlot? (*c*) What kinds of lots would be used for this purpose on these farms? (*d*) What do farmers say about the ability to sell woodland products? (*e*) Get their opinions regarding the planting of trees, for profit and for the public good.

2. **Choosing the types and varieties of trees**, pp. 319–321; *Farm Projects*, 329; *Bulletins*, 622, 1071, 1123, 1208, 1256, 1392, 1453, 1486, 1517, 1628, 1664, 1671. *Local inquiry.*—(*a*) Local authorities can help you in deciding best varieties to plant in your region for different purposes. (*b*) Find what rapid-growing trees are best suited to your region. (*c*) Make a list of local trees in tabular form giving for each: name, rapidity of growth, special uses, and methods of propagation. (*d*) Get farmers to discuss hard-wood trees *vs.* soft-wood trees for planting.

3. **Locating area; preparing**, pp. 323, 324; *Farm Projects*, 329. *Bulletins*, 622, 1071, 1123, 1208, 1209, 1256, 1405, 1453, 1486, 1603, 1644. *Local inquiry.*—(*a*) List the kinds of places where trees could be grown without interfering with other crops. (*b*) Discuss with farmers how areas can be prepared economically. (*c*) Where woodlots are already started decide how to prepare the area for planting additional trees. (*d*) Find what special methods of preparation can be used on stony areas, on swampy areas, on steep hills, and on stump lands. (*e*) From the experience and opinions of farmers decide on the size of your woodlot.

4. **Selecting and procuring trees and seeds; planting**, pp. 319, 325; *Farm Projects*, 330, 331, 335; *Bulletins*, 622, 1123, 1208, 1209, 1256, 1405, 1453, 1486, 1567, 1591. *Local inquiry.*—(*a*) Locate nurseries that sell forest tree seeds and seedlings. (*b*) Compare prices. (*c*) Obtain local ideas regarding the growing of your own seedlings. (*d*) What plans of planting are advocated? (*e*) Calculate the cost for trees and for seeds for planting your own lot or a neighbor's woodlot.

5. **Maintaining the plantation**, p. 323; *Farm Projects*, 332, 333; *Bulletins*, 622, 1071, 1123, 1177, 1197, 1209, 1256, 1398, 1405, 1453, 1486, 1641, 1654, 1672. *Local inquiry.*—(*a*) Find examples of good and poor maintenance. (*b*) Compare the best local practices and those given in Bulletin 1177. (*c*) What local losses have occurred from fires in woodland areas? How could they have been prevented? (*d*) Get opinions of farmers regarding the pasturing of the farm woodlot, for and against.

6. **Harvesting woodland products,** pp. 323, 324; *Farm Projects*, 333; *Bulletins*, 622, 1117, 1177, 1210, 1256, 1660, 1680. *Local inquiry.*—(*a*) Let farmers give their ideas of scientific harvesting. (*b*) Talk with farmers regarding harvesting points, such as: cutting of diseased and misshapen trees; cutting ripe trees; cutting inferior trees to make room for better ones; height of cutting stumps; securing sprouts from stumps; harvesting without injuring undergrowth; disposal of brush and waste after cutting.

7. **Marketing and using products,** p. 323; *Farm Projects*, 328, 333, 334; *Bulletins*, 622, 744, 1071, 1117, 1210, 1256, 1392, 1405, 1459, 1582, 1660. *Local inquiry.*—(*a*) List the tree products for your region. (*b*) How are these used or sold? (*c*) Ask farmers for opinions on ideas given in Bulletin 1100. (*d*) How are woodland products usually sold by local growers? Obtain prices.

CHAPTER XX
WOODLAND PROJECTS

On many farms, large or small, in humid regions and in dry prairie regions, woodland areas are often set apart for the growth of wood products for sale or for home use. In the prairie regions such an area is often started as a shelter belt of trees to form a windbreak from north, west, and southwest winds. In humid climates where native woods existed in advance of human settlers, trees grow more naturally.

The choice of a plot for the woodland area in hilly regions may be a hillside rather too steep for cultivation or permanent pasture; the growth of timber on it will prevent washing even better than sod. Often a natural woodland area that could be cleared is reserved as a permanent woods. Rocky fields, gravelly soils or other poor lands are sometimes found to be fairly well suited, and better adapted, to the growth of timber than to any other form of agriculture.

In attempting to decide the value of a woodland project it may be worth while to enumerate products which the woods may supply: Nuts and fruits, sugar and syrup, quinine, salicin, oils (sassafras, eucalyptus, beechnut and olive), matches, toothpicks, clothes pins, pencils, penholders, handles, baskets, spokes, veneer, shoe pegs, wooden dishes, wood alcohol, acetates, wood tar, potash, turpentine, resin, creosote, pitch, cork, tannic acid, charcoal, gum, lamp black, excelsior, lumber, posts, poles, ties, fuel, pulp, and many others that might be named.

The home fuel supply, poles, posts, rails, and lumber are particularly valuable for the farm.

Trees for Planting.—Where old woods existed, new trees to fill their places may be needed. When new lots or fields are to be planted young trees must be secured. Forest nurseries are to be found in many states. Very young seedlings of the species desired may be bought by the thousands at low prices. Seedlings may be started early in the garden by collecting or buying seeds and planting them in rows, allowing room for cultivation. Most nut trees, the tulip tree, and others with tap roots should be transplanted to the woodland while very young. Those with fibrous, shallow roots may be allowed to remain in the nursery until larger.

Forest Plantings.—Forest trees and shelter belts should be planted in rows if cultivation is desired. (Fig. 215.) In dry climates this is usually necessary. Shelter belts should be made about six rods wide and the trees planted close together to cause them to form tall, shapely trunks with narrow, short crowns rather than short, limby trunks which would make knotty lumber.

Suitable distances would be four feet apart each way. An intercrop of Irish potatoes or something else requiring clean cultivation may be grown. In some cases farmers set the trees two feet apart

FIG. 215.—Woodlot of fourteen-year-old pines, in poor clay soil, originally prairie. (Kansas State Agricultural College.)

in rows eight feet apart. This allows the growth of cultivated crops between the rows for several years.

Mixing Varieties.—Sometimes mixed stands are desired. Some species develop better mixed with other trees than in pure stands. There is less loss from drouth, insects and disease. When a mixed setting is desired, it is a good plan either to study what species are found growing together in forests of similar sites or localities of the region, or to consult some authority as to a good mixture.

Kinds of Trees.—In regions where native woods prevail it is well to select the present species which are known to suit the region and soil. For producing timber those species should be chosen which will bring good market prices for the particular products desired, as lumber, poles, ties, and posts. Chestnut groves are usually profitable outside of the region of the chestnut blight disease. The black walnut yields valuable products and grows in

regions somewhat drier than trees having shallow roots. The cottonwood and other poplars (Fig. 216) are sometimes the only trees found along streams in prairie regions and cold climates. The

FIG. 216.—Windbreaks of poplar trees protecting valuable orchards along the Columbia River from wind and shifting sand. (Snyder's Fights of the Farmer.)

wood is chiefly used for fuel. Their cuttings will root easily. Pecans should appear in the lists for southern regions. Sugar maples should be grown in cold climates for lumber and syrup.

FIG. 217.—Yard containing 60,000 posts and 650 ricks of stove wood cut from 20 acres of 16-year-old hardy catalpa trees. (Kansas State Agricultural College.)

The hardy catalpa tree (Fig. 217) is well suited to the central sections, but requires rich, moist soil. The wood is extremely valuable for posts and poles, and is very durable. The red cedar makes good posts and valuable lumber, but because of rust disease which comes from it, the cedar should not be grown where apple orchards are desired. In the pine belt the native species should be chosen. The black locust makes good posts and is a rapid

grower. The oaks are slow growers but produce valuable lumber and ties.

Principles of Good Forestry.—The woodland area should be so managed as to be permanent and produce a crop regularly for home use and for market. (Fig. 218.) The following principles should be observed: (1) Only the ripe trees should be selected when cutting the crop. (2) Injury to small seedlings and saplings should be avoided. (3) Diseased and misshapen trees should be removed, and used either for the market or at home. (4) The inferior trees should be removed if the space is needed for better ones. (5) A few large trees should be left to reseed the woodland. (6) Pasturing with animals that will injure the young seedlings should not be permitted. (7) Fires should be excluded and notices calling attention to fire damage to forest growth should be posted. (8) The stand should be thinned so as to secure the best growth, but heavy thinning is not desirable. (9) Sprouts from stumps form stands called coppice. These should also be thinned, leaving the best sprouts. (10) Trees damaged by storm should be removed before they are attacked by insects and disease, which would spread to others. (11) Brush and waste after all cuttings should be piled and burned.

Forests benefit regions in a number of ways: (1) They greatly modify and improve climate. (2) They greatly equalize temperature. (3) They break the force of the wind. (4) They check evaporation. (5) They prevent floods or make them less serious. The forest itself and its floor of leaves and trash absorbing the rainfall, retard the rush of water to streams. (6) Water power for mills and factories along streams is more uniform because of a steady supply of water coming from a stream through a well-protected forest watershed. (7) Wells and springs are more continuous in their flow because more water enters the soil and gradually seeks the underground currents.

Optional Studies.—Studies may be made regarding the national forest reserves, national parks and state and federal forestry work.

Surveys, Trips, Problems, Projects, and Exercises

1. **Woodland Survey.**—Include in this survey such topics as the following: Plantations mostly natural or artificial; kinds of sites (Fig. 219); leading species; costs; how planted or rejuvenated; means of maintenance; scientific or haphazard harvesting; kinds of products; returns from sales; probable annual yields.

Fig. 218.—Timber and wood should be the perpetual crop of the woodlot. Trees are cut without injuring the younger growth, and brush is burned to prevent the breeding of insects. (U. S. D. A.)

Fig. 219.—Such rocky land should remain in permanent woods instead of being left a barren waste. (U. S. D. A.)

2. **Problems.**—(1) Calculate average costs per acre for planting trees; (2) compare percentages gained by growing seedlings instead of purchasing; (3) calculate the annual maintenance; (4) average woodland area including interest on investment, taxes, and labor; (5) compare forest returns from the area with probable returns of other kinds.

3. **Debates.**—"Home production *vs.* purchasing of woodland products for home use." "Forestry *vs.* orcharding for steep hillsides and rocky places." "Growing of wood *vs.* purchasing of coal for fuel." "Scientific *vs.* haphazard production of woodland products."

4. **Woodland Projects.**—As suggested at the beginning of this chapter, projects in areas to be devoted to scientific forestry should be planned

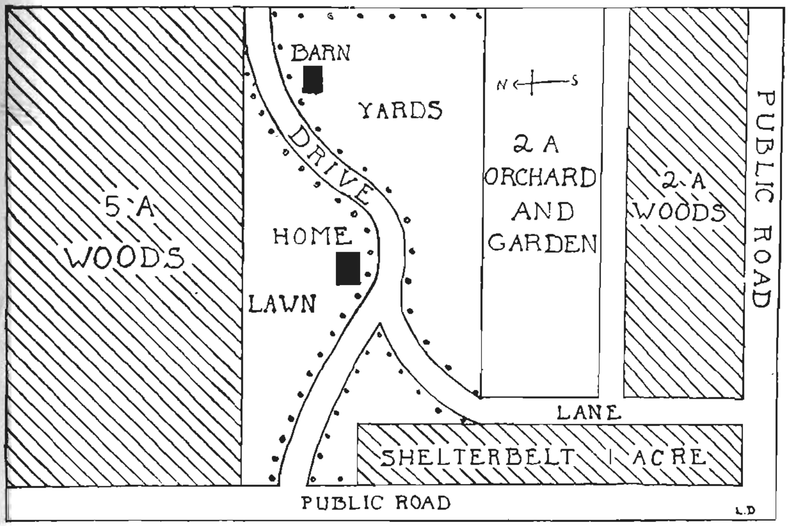


FIG. 220.—This farmstead has three shelter belts, suited to the level prairie region. The buildings, garden and orchard are protected from the worst winds on north, west and south. (Adapted from U. S. Bureau of Forestry.)

by students. Plans will need to be made to suit individual cases. (Fig. 220.) In states where woods grow naturally the rejuvenation and planting of a natural woodland may be accompanied by annual care and scientific harvesting. In prairie states the project may need to begin with the first preparation and planting of the area. (Fig. 221.)

5. **Subjects for Charts.**—(1) Make a list of trees well suited to the region and the characteristic uses of each. (2) Enumerate the chief points in scientific harvesting. (3) Enumerate the costs in annual maintenance for a ten-acre lot. (4) Benefits of forests.

6. **Field Trip.**—Visit neighboring woodlands to study suitability of sites, species of trees, means of reseeding, judging the stand, selecting trees for next cutting, methods of harvesting, and forest enemies.

7. **Exercises.**—Collect from lumber yards and planing mills samples of wood of different species. Cross-sections and longitudinal sections may be shown. All should be in the rough finish, and also in the planed or polished form. Make a collection of other forest products. Collect and study leaves of the leading forest trees.

Questions and Investigations

1. Why should farms in prairie states have woodland areas?
2. Give a list of products supplied by woods. Which are most important?
3. Describe a wooded area you have seen on some farm.
4. Tell how to improve this as a woodland.
5. Give directions for making a new forest plantation.
6. Give advantages of mixing varieties.
7. What kinds of trees would you choose for your region?

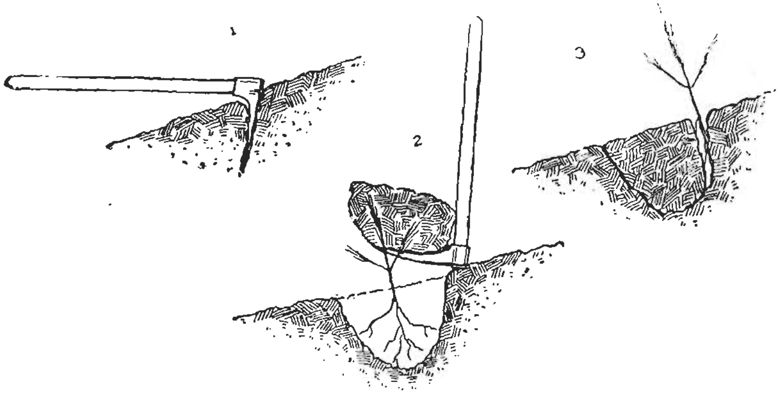


FIG. 221.—The mattock method of rapidly planting forest trees. (Cornell Reading Lesson 159.)

8. Which of these grow quickly and which slowly?
9. Which are best for lumber and which for poles or posts?
10. Give ten principles of good forest practice.
11. Give a list of regional benefits of forests.

Farm Mechanics.—Make or repair and sharpen pruning tools and timber tools; make timber calipers; log hoist; saw buck; mount wood saw; cut posts and poles before setting; cap posts in fences; make cabinet of wood samples for school use.

Calculations.—1. From a 10-acre woodlot a farmer sold in one year 28 poles at $7 each; 150 posts at 35¢ each; 13,000 board ft. of lumber in saw logs at $10 per thousand; 80 cords of fuel at $3 a cord. Find his total income from the woodlot not counting labor.

2. If this farmer paid out 25 per cent of the above income for labor and considered the balance his labor income for himself and son and teams at idle times, find his labor income.

3. A young man sets 10 acres of woodland using 9,000 pines at $2 a thousand; 12,000 locusts at $1.50 a thousand; and 10 bu. of walnuts at 50¢ a bu. After getting the woodland started a committee valued the plantation at $20 an acre increase over the former value. What was his labor income? Allow $1 an acre paid his younger brother for help.

SWINE ENTERPRISE

Analysis into Jobs.—The following jobs include the main operations in the pursuit of swine enterprises. References are to pages in *New Agriculture*, Davis' *Farm Projects and Problems*, and to numbers in available *U. S. Farmers' Bulletins*. See also Anderson's *Swine Enterprises*.

1. **Deciding whether or not to raise swine,** p. 325; *Farm Projects*, 355; *Bulletins*, 1437, 1504. *Local inquiry.*—(*a*) Talk with the county agent, with farmers and with buyers regarding the profits from swine. (*b*) Compare local prices of corn with prices of pork. (*c*) At a ratio of five pounds of corn to one pound of live pork, calculate the net income on the farm of one of the best swine growers. (*d*) What serious drawbacks, if any, have confronted swine growers recently?
2. **Choosing the breed of swine,** pp. 325, 326; *Farm Projects*, 356–360; *Bulletins*, 1244, 1263, 1437. *Local inquiry.*—(*a*) Make a list of the breeds of swine of your region. Compare them in popularity and find reasons. (*b*) Get grower of each breed to criticize and defend his breed. (*c*) Ask what the market requires as to types of pork and size of carcass.
3. **Selecting and procuring breeding stock and feeders,** pp. 328, 329; *Farm Projects*, 361–363; *Bulletins*, 1244, 1263, 1437, 1455. *Local inquiry.*—(*a*) How do local farmers secure their breeding stock? (*b*) Find how many pure-bred animals are kept on different farms. (*c*) What proportion of these are registered? (*d*) Get the opinions of farmers regarding crossing of breeds and use of pure-bred boars and sows. (*e*) Try to find the ideals of farmers regarding good types of breeding: for feeding.
4. **Planning swine quarters and equipment,** pp. 331, 333; *Farm Projects*, 363–364; *Bulletins*, 1437, 1487, 1490, 1502. *Local inquiry.*—(*a*) Visit and describe the best hog quarters; the poorest. (*b*) Calculate the total cost of different equipments found. (*c*) Compare economical equipment with expensive equipment.
5. **Planning rotations and pastures for swine,** pp. 330–332; *Farm Projects*, 367; *Bulletins*, 1133, 1151, 1229, 1339, 1437. *Local inquiry.*—(*a*) Find how many farmers have permanent pastures only. (*b*) How many have temporary pastures in regular rotation? (*c*) How many have no green pastures for their swine? (*d*) Study the crops suitable for swine pastures in your region. (*e*) Ask farmers to enumerate the advantages of having several temporary pastures in rotation. (*f*) What farm crops are raised on the best swine farms?
6. **Feeding swine,** pp. 333–334; *Farm Projects*, 366–370; *Bulletins*, 1133, 1229, 1437, 1504. *Local inquiry.*—(*a*) Find what farmers supply mineral feeds regularly. (*b*) Divide the first six months of the pig's life into four equal periods and ask farmers what feeds they supply in each of these periods. (*c*) Get farmers to compare the different materials used as supplements for corn.
7. **Managing and caring for swine,** pp. 333–335; *Farm Projects*, 365–367; *Bulletins*, 926, 954, 1133, 1437, 1504. *Local inquiry.*—(*a*) Find what special care farmers give at farrowing time. (*b*) Compare the sizes of litters raised with the answers obtained in (*a*). (*c*) Compare the sizes of litters raised with the pasture systems found. (*d*) Compare farm management with and without the ton-litter system.

8. **Controlling diseases and enemies,** pp. 335, 336; *Farm Projects*, 371–373; *Bulletins*, 781, 834, 926, 954, 1018, 1085, 1244. *Local inquiry.*—(*a*) Compare health and disease on sanitary and unsanitary farms. (*b*) Study the relation of hog-wallow to health of swine. (*c*) Study the relation of pasture systems to health of swine.
9. **Keeping swine records,** pp. 18, 19, 330, 338; *Farm Projects*, 32–35, 77, 78; *Bulletins*, 511, 572, 782, 1182. *Local inquiry.*—(*a*) Make a survey of many swine growers on record keeping. (*b*) Describe the best record you find kept. (*c*) Get reasons of farmers for and against record keeping.
10. **Improving the breeding stock,** pp. 329, 330, 332; *Farm Projects*, 375; *Bulletin*, 1263. *Local inquiry.*—(*a*) Ask swine growers what points they consider when culling out the old sows. (*b*) Get their opinions regarding maximum age for breeding stock. (*c*) Inquire regarding points to consider in buying young breeding stock. (*d*) Get copies of pedigrees of swine and compare those in the same breed.
11. **Showing and selling breeding stock,** pp. 338, 339; *Farm Projects*, 373–375; *Bulletin*, 1455. *Local inquiry.*—(*a*) Find what growers exhibit swine at fairs. (*b*) What methods are used in selling breeding stock? Compare these. (*c*) Find what preparation is made for swine before showing and before selling.
12. **Marketing swine,** p. 340; *Farm Projects*, 376; *Bulletins*, 1186, 1502. *Local inquiry.*—(*a*) How many grocers sell dressed pork? (*b*) What products? (*c*) Find the ages at which live hogs are sold for market from your region; what weights? (*d*) Find the top prices of live hogs for the last few years. (*e*) Compare these with prices at the same time in large markets. (*f*) Find why coöperative marketing is not more generally practiced.

CHAPTER XXI

SWINE ENTERPRISE

When farmers or students are beginning the business of swine production there are four principal ways of starting their projects: (1) Beginning with bred gilts. (2) Beginning with weanling gilts. (3) Beginning with sows and litters. (4) Beginning with a rather uniform bunch of shoats for growing, feeding and marketing.

The scope and time of the first plan may be made so inclusive as to cover each of the other plans. The topics in this chapter are considered in the order of the natural operations or seasonal sequences for the first plan. Students and farmers selecting one of the other projects may begin at the corresponding topic and follow the same order around the cycle of the project. Other project suggestions are given at the close of this chapter.

Selecting the Type.—This is usually the first step for the beginner in swine husbandry. There are two very distinct types of swine. The *lard* type is far more popular in America and is noted for the thick fat produced. The *bacon* type is increasing in popularity, particularly in northern and eastern markets and in Canada. It is noted for the production of bacon in alternate layers of lean and fat. The lard type is best suited to the corn belt of the United States, and because of the predominance of swine from the corn belt in our markets, the few bacon hogs produced there and in other sections have made very little impression upon the pork trade. When sold by liveweight lard hogs have almost invariably exceeded the bacon hogs in price per pound in our markets. Rarely has the price for bacon hogs been ahead. The reverse is usually true in Canadian and English markets.

Hogs somewhat intermediate in type between the two extremes are becoming very popular.

Lard Type Hogs.—The name "fat type" would better describe this group. The body is compact, thick, deep and smooth. Depth and thickness rather than extreme length are wanted. All parts are developed symmetrically and blend smoothly together. Watch for good development of the hams, back and shoulders. When ready for market such hogs are extremely fat and smooth. Such hogs dress a larger percentage of flesh than others. A small proportion of waste is desirable in all types. Quality in fat hogs

is indicated by general smoothness, clean skin, fine hair and fine bone. Coarseness in any particular is objectionable.

The chief breeds of fat hogs are Duroc-Jersey, Poland China, Berkshire, Chester White (O. I. C.). Less important breeds are Cheshire, Victoria, Small Yorkshire, Essex, and Suffolk.

Bacon hogs must be just right to meet market demands. The live weight should be 160 to 200 pounds. Good development of side between the shoulder and ham, particularly in the upper half of the ribs and in the loins, is demanded. The bacon type is best described by contrasting it with the fat type. The body and legs are longer. There is less thickness and depth of body, lighter in the neck, jowl and shoulder, and there is little development of belly meat. Quality is indicated by smooth hair, good chest development and other indications of thriftiness: firmness of flesh, freedom from wrinkles, alertness, and heavy bone.

The leading bacon breeds are Tamworth and Large Yorkshire. The Hampshire breed was at one time often classified here.

Selecting the Breed.—After selecting the type of swine the beginner should make a study of the breeds. After becoming familiar with their general characteristics he may make local studies to determine more definitely between those which he may prefer.

Duroc-Jersey.—This red breed is very popular in many swine-growing sections. It is of the fat type and a rapid grower. Its coarseness has sometimes placed it a little lower in the markets than Poland Chinas and Berkshires. Recent improvements of the breed tend to remedy this criticism. The snout is rather straight and the large ears are pendulent at the tips. Duroc-Jersey breeders make strong claims for the numbers of pigs in litters.

Poland China.—This is a black breed with white points about the face, feet and tail, and for many years was the most popular breed in the United States, and still holds a good place. Much attention has been given to early maturity and good quality in this breed at the expense of small litters. Two distinct strains of the breed are known, differing in size and some other characteristics. The large Poland China is now much more popular. The snout is medium and rather straight, and the ears are about one-third drooping. (Fig. 222.) The spotted Poland China is a well-recognized breed seen at large fairs.

Berkshire.—This is a black breed with white markings on the face, feet and tip of tail. The face is moderately dished, the snout medium in length and the jowl rather heavy. The ears are unusu-

ally erect. The breed is characterized by fine bone, erect toes, good heart girth and very strong rump and hams. While Berkshires are usually of the fat type, bacon strains are used in Canada and England. Pigs develop well while young and sows produce good-sized litters. In economy of pork production the Berkshire has stood well.

Chester White.—This is a white breed formerly of very large size but now more comparable in size with Duroc-Jersey and Poland China, or a little larger. The face is straight, the snout

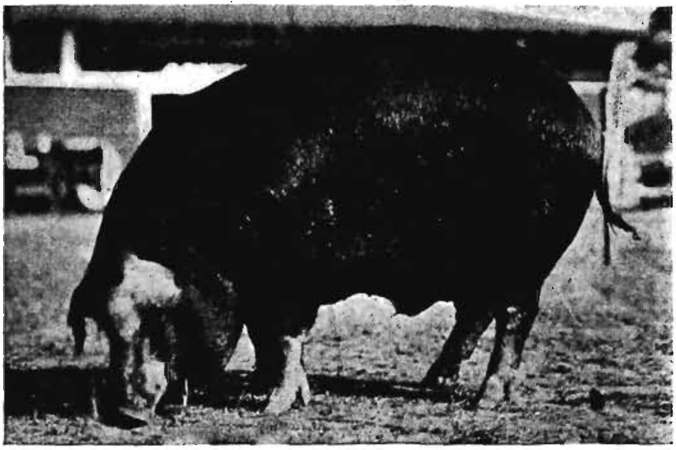


FIG. 222.—Champion fat barrow, weight at seven months, 367 pounds. (Florida Station.)

rather long, the ear heavy and somewhat drooping. The body is somewhat longer and the quality coarser than the Poland China. The Ohio Improved Chester, called the O. I. C. strain, is very similar to the modern Chester White. The breed is preëminently of the fat type. The pigs mature fairly early and meat is produced economically. They are good grazers. The white skin makes them subject to skin troubles when exposed to hot sun and all kinds of weather. The litters are probably somewhat larger than in Poland Chinas and Berkshires.

Hampshire.—This is a black breed of medium size with a white band or belt four to twelve inches wide encircling the body and including the fore legs. The face is straight, the snout medium, the ears are inclined forward but not drooping as in Poland Chinas. Hampshires are somewhat lighter in type than the typical fat hogs, particularly in jowl, shoulder and ham. The

bone is light and the quality good. They are somewhat medium in type between the true fat hog and the true bacon type. They mature early, make economical gains in weight, and credits are given for large litters. The hogs are good grazers, good mothers and make excellent crosses with larger breeds.

Bacon Breeds.—*The Tamworth* is more popular in most sections than the Large Yorkshire. The legs are rather long, the snout long and the body high and long and bones strong. The color is red. The pigs develop rapidly and the sows produce large litters and are good nursers. They do not fatten at a young age but will produce rather fat bodies if fed long enough. Nature seems to have made them preëminently suited for producing bacon economically.

Large Yorkshire is sometimes called the Large White Breed because of its color and size. The snouts are less turned up than formerly, the body is a little heavier in build and the legs shorter and bones usually finer than in Tamworths. The breed is most popular in Minnesota, the Dakotas and Canada, but is found in all the states. Skin troubles are likely to be produced by exposure, particularly in hot climates. The best type of Large Yorkshire has a good constitution, good quality, and has rather economical feeding qualities as a producer of bacon meat.

Breeds of the Region.—Students should study the points claimed by local breeders for the breed they are using. The leading breeds have strains which differ in various sections. Certain local adaptations to grazing or other methods of feeding may be found. A local survey covering these points would prove beneficial in selecting breeding stock. All swine growers of a region should agree on one breed, as this will aid in marketing.

Ways of Securing Stock.—If bred gilts are to be purchased the beginner must decide between those produced locally and others purchased from reliable breeders in other sections. As much depends upon the type of individual in swine production it is important that opportunity be found for selection and judging of each animal to be purchased. Reliable breeders may honestly ship their best to buyers and yet not suit the buyers because of differences in ideals and standards. Some buyers want show hogs while others want utility animals. In all breeds there are differences in both of these.

Purchasing locally gives the buyer opportunity for individual selection. His choice may be limited by a small number of herds. These local herds may also have been badly inbred or their owners

may have been one-sided in their breeding standards. Purchasing locally saves express charges, risk in getting the proper type, and may avoid the introduction of diseases.

Sows vs. Gilts for Breeding.—The chief objection to the purchase of bred gilts is that some never make good mothers. Certain individuals always produce small litters. Choose those with long bodies and good number of rudimentary teats. A good

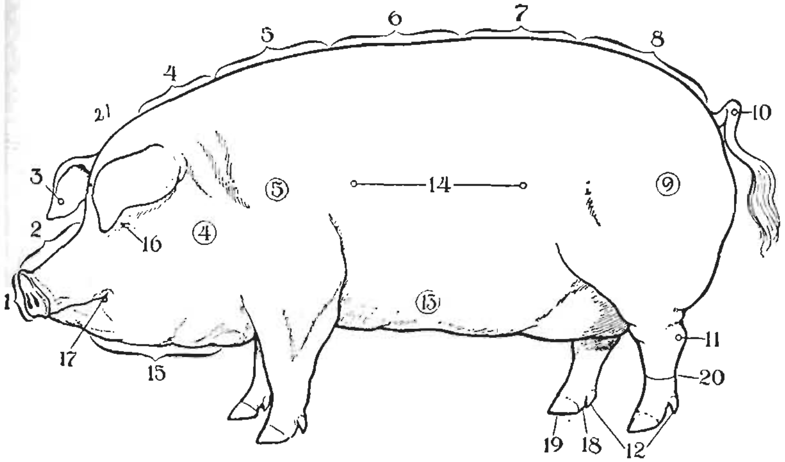


FIG. 223.—Parts of fat hog. (American Duroc-Jersey Association.)

1. Snout, short not coarse.
2. Nose, not too long.
3. Ears, well carried, fine, medium size.
4. Neck, thick, short, smooth to shoulder.
5. Shoulder, broad, deep, smooth, compact on top.
6. Back, broad, slightly arched, thickly and evenly fleshed.
7. Loin, wide, thick, strong.
8. Rump, long, wide, evenly fleshed.
9. Ham, heavily fleshed, full, firm, deep, wide.
10. Tail, not coarse.
11. Hock, vertical viewed from rear.
12. Dew-claws, carried well up.
13. Belly, straight, smooth, firm.
14. Side, deep, full, smooth, medium length.
15. Jowl, full, firm, broad, neat.
16. Eye, large, full, clear, wide apart, not obscured by wrinkles.
17. Tusk, not coarse.
18. Pastern joints, short, strong, upright.
19. Feet, medium size.
20. Bone measurement, medium size, clean, strong.
21. Forehead, broad.

constitution as shown by heart girth, carriage of feet, grazing qualities and general alertness are important.

Sows which have proved to be good brood sows by the production and raising of at least one good litter may be bought by the beginner at less risk. They are usually more expensive and their ability to produce may not be maintained.

Score Card Study of Individuals.—In choosing breeding stock, records are one thing and individuality another. A score card should be used in determining the individuality. (Fig. 223.) It will call attention directly to every important point. Laboratory supply companies furnish such score cards in tablet form for such use. The main points to use are the general type and breed char-

acteristics, the quality, the constitution, and such breeding elements as early maturity, size of litters, length of body, digestive capacity, and nursing ability.

Pure Breds vs. Grades.—In deciding whether to purchase registered pigs or not the buyer must decide what he intends to do with the offspring. Pure breds will sell at much higher prices than grades and the extra cost of producing them is very slight. Write to the secretary of the breeding association of the breed selected to ascertain the cost of registering pigs, and of membership. Make inquiry as to popular prices of both grades and registered pigs. Take pride in being the owner of pure-bred livestock. Become a careful breeder and make a reputation for your animals.

Pedigree and Records.—The pedigree of an animal is a record of his breeding for a number of generations. It not only shows purity of blood but exactly what strains enter into it. Animals with splendid reputations may be recorded in the pedigree. A breeder should know: (1) What premiums they or their ancestors have won at local, state, or national fairs. (2) What sizes of litters are shown by their dams and other ancestors. (3) What utility records, if any, can be found—as economical meat production.

Swine are tested for performance by station feeding trials. using a part of each litter shipped by the owner to the station. Such work gives a hog raiser data for selecting his breeding stock.

Number of Sows or Gilts to Buy.—The beginner without previous experience in swine growing should not be too ambitious at the start. Three to five gilts, well cared for, are better than twice that many neglected. Strive to raise all the healthy pigs that are farrowed and the numbers will increase rapidly.

If the area be small and so limited as not to supply plenty of pasture room, this will limit the number of gilts to purchase. On the other hand, if the equipment is good and all surroundings are favorable the number may be much increased.

Green Feed for Swine.—No element in the economical production of pork is more important than suitable pasture areas or other means of supplying plenty of green feed. The hog is naturally a pasture animal. During his first five months of life he should have an abundant supply of green forage. No other feed can take its place in production of growth, bone and lean meat. Not only is it the best but it is the cheapest. No swine should be restricted to a dry lot or pen except those being finished for market.

Suitable Crops for Swine Pasture.—In making plans for green pasturage for swine consider both permanent and temporary

pastures. Plan for winter as well as for summer. Even where snows remain for several weeks late fall and early spring pastures should be provided.

Low, pig-tight fences of woven wire should be provided around several fields so that crops may be planned and grown in advance ready for pasturage when needed. (Fig. 224.) A movable house or other temporary shelter may be used to protect pasturing swine from winter storms and from summer sun. Provide water either in each pasture or near enough to avoid travelling long distances each day to secure it. The following plan is merely suggested. Modify it to suit local climates and soil conditions.

Fig. 224.—Temporary fences for swine and sheep may be quickly fastened to stakes by use of two eye screws and a wire rod. (North Dakota Station.)

For winter and spring have winter grain sown early the preceding fall. With this may be mixed winter vetch or crimson clover.

For late spring and early summer use spring-grown grain mixed with spring vetch or Canada field peas or rape.

For mid-summer provide a field of red clover or alsike clover or a permanent pasture of blue-grass, white clover or alfalfa. For late summer and early fall plan to have fields of soybeans, cowpeas and such crops as those mentioned for mid-summer.

For fall and early winter, have rape pasture (Fig. 225) and small grain such as rye sown in mid-summer. Alfalfa is an excellent swine pasture at different seasons.

Areas needed for pasturage depend upon the amount of rainfall, the number and age of swine, and the success of the stand.

Two acres of good red clover may supply five to ten sows and their litters with an abundance of green feed for two months. It is better to supply too large an area than to pasture it so closely as to kill the crop. When crops are growing thriftily ten or more shoats per acre may be fed well.

Best Feeds for Breeding Stock.—Sows producing milk for their litters should be given much milk-producing feed instead of

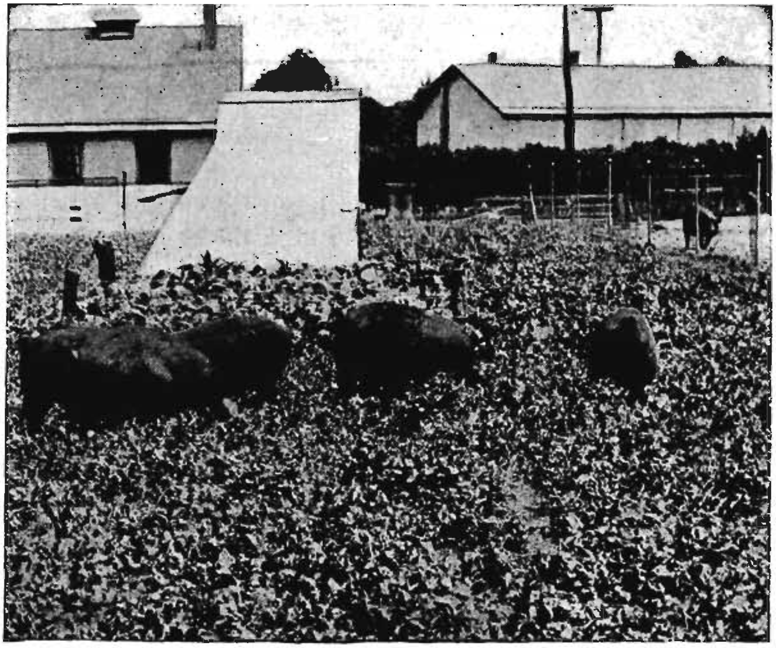


FIG. 225.—Young gilts on rape and sweet clover forage in June. (New Jersey Station.)

corn. A good proportion of milk-producing feeds should be supplied. Pasturage is the cheapest and the best. This should be supplemented with wet feeds such as slops made from middlings and water, or skimmilk. The danger of feeding corn alone is that the sows, either before or after farrowing, will be too fat or fail to supply milk, and will not have sufficient mineral matter. Corn in limited quantities may be used for sows and litters having plenty of leguminous pasturage. Whenever corn is used in their ration, supplement it with skimmilk, with mill feeds rich in protein or with tankage.

Mineral Feeds.—Growing pigs and breeding stock require an

unusual amount of mineral matter. Pigs naturally root in the ground and get minerals which the farmer needs to supply under domestication. Several materials may be mixed together and used for this purpose: Wood ashes, coal ashes, coal dust, charcoal, salt, saltpetre, sulfur, copperas, lime dust, and rock phosphate dust. A few or all of these materials may be mixed together and placed in a suitable feeding hopper or in a pit where swine have constant access to it. Do not mix these minerals with grain or other feed for swine. Farmers often gather corn-cobs in pits and char them for this purpose.

Mineral elements are needed in the body for growth of bones, for the formation of blood, for the supply of minerals in lean meat and to aid in the proper secretion of digestive fluids. Sows with young pigs are less likely to form pig-eating habits.

Feeding at Farrowing Time.—Special feeds for sows should be supplied as farrowing time approaches. Warm bran mashes are good if the winter is cold. Thin mashes made from mill feeds mixed with skimmilk should constitute the chief ration before and after farrowing. For very heavy or fleshy sows supply laxative feeds, such as mashes containing linseed meal.

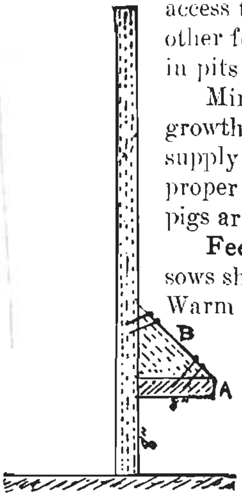


Fig. 226.—Guard rail for farrowing pen; eight inches wide and eight inches from floor, showing method of fastening. (Day's Productive Swine Husbandry.)

Housing.—For late fall, winter, or late spring litters provide comfortable housing quarters. Saving of young pigs from death will soon pay for good quarters. The house need not be expensive. The floor, if made of concrete, should be well insulated with an under layer of tar or tar paper so that the top will be warmed by the sow's body. Sometimes temporary platforms are laid over cold concrete floors. Bedding must not be too abundant for fear of pigs being mashed by their mothers. It should be changed often to keep it dry. Around the sides of farrow pens provide a shelf or rail for pigs to slip under and avoid being mashed by their mothers. (Fig. 226.) Each sow and litter should have a space in the house about eight by eight feet. When permanent houses are built place them where drainage is good, where summer sun may enter and where shade can be provided in summer. A good wind break as a fence or line of evergreen trees on the west and north sides should be provided if possible.

Movable houses are well suited for sows and litters in the summer and in warm climates in other seasons. Figure 227 shows a low form of movable house provided with a wooden floor, which can be readily drawn from one field to another by a team of horses. If each such movable house is provided with a small lot with pasturage, the litters can be kept separate until weaning time.

Care at Farrowing Time.—The date of breeding will indicate closely when farrowing is expected. Take every precaution possible to have all conditions favorable. The sows should be separated from all other swine. Have the bedding clean and dry but not too abundant. Not only should the sow be fed with laxative feeds as already suggested, but she should be given a purgative unless her digestive tract is loose. Have the quarters warm and free from cold winds. An attendant should be present to aid in all emergencies without making the mother nervous. Chilled pigs should be warmed by the use of warm stones or bricks in a box covered with carpet. Hot-water bags are sometimes put against them. When pigs have been chilled be sure that they get a drink of their mother's warm milk, and are not prevented by other pigs. Needle teeth are extra teeth found in pigs' mouths at birth. Examine pigs' mouths and remove such needle teeth before they have injured themselves, each other, or their mother's udder. This may prevent sows from attacking their pigs. Such sows as have pig-eating habits should have the pigs removed from them except at nursing times. Give such a sow plenty of tankage and other protein feeds and plenty of mineral matter. In a few days, perhaps, the pigs can remain with her without danger. Never feed brood sows on corn alone.

Fig. 227.—Movable A-house for sow and litter.

If more pigs are born than the mother has teats with which to feed them, the owner must decide what to do. Perhaps one pig can be given to another litter of the same age. Perhaps attention at nursing time may allow all pigs to secure the mother's milk. Other milk can be supplied after the first few days when pigs learn to drink.

Feeding Pigs in Pig Creep.—Provide a corner where pigs can

retreat from their mother to a trough supplied with milk or wet mash. Such a plan will save much drain upon the mother's system; will develop the pigs more uniformly and rapidly; will cause the pigs to learn to eat much younger; will cause less shock at weaning time and will allow the owner to plan on two litters a year from each sow. Good feeds to use in the pig creep trough are middlings wet with skimmilk. Blood meal and tankage are also used. Pastures should be available not only for the mother but for the pigs.

Exercise.—From what has been said about pasturage a discussion of exercise seems superfluous, but where pastures are not supplied exercise should be provided in some other way. The shelter and sleeping quarters may be at one side of the lot and feeding at the other. This will cause the swine to move back and forth frequently. Provide some such plan for natural exercise.

Sanitation.—All swine are subject to intestinal worms, lice, cholera and other troubles. Sanitation is the best precaution. Pigs are naturally sanitary creatures if they are given facilities in quarters that are favorable. Worms are taken into the system by pigs getting the worms into their mouths. This may be from filthy wallows or from the udders of their mothers. Prevention consists in keeping the quarters disinfected, the wallows clean and the feeding places fresh. Pour a little crude oil on hog wallows to prevent breeding of worms and other enemies. Drain and renew them occasionally.

If swine be infested with worms they are very unthrifty in appearance and their feed seems to fail in producing proper returns. Treat them with five grains of calomel and eight grains of santonin for each hundred pounds liveweight. Put the medicine in feed or give it as a drench. A teaspoon of turpentine for a hundred-pound hog is recommended for thorn-head worms. Give the dose three days in succession.

Lice.—Dips are very effective in thoroughly eradicating lice from swine. The sleeping quarters must be cleaned up and disinfected at the same time. Many farmers systematically oil the hogs, using crude oil for the purpose. If the hog wallow is provided with a scum of crude oil, hogs will naturally keep themselves well oiled.

Another good plan is to feed the hogs with shelled corn or other grain and while they are bunched together to eat, sprinkle them with oil from a garden sprinkler until all are saturated. It may be necessary to spray them a little underneath as they must be wet all over with the oil. A rubbing post provided with burlap saturated in oil will do much good but other methods are needed to supplement this.

Hog cholera is usually in regions where swine have access to flowing streams, the disease being carried from herds up-stream to others. When-

ever hog cholera is likely to be prevalent all swine should be immunized by the so-called double treatment. This consists in inoculating each animal with enough virus to give the disease and at the same time inoculate him with enough serum to control the disease. Such double treatment renders pigs immune for life. It can be done about two weeks or so after weaning. At this age the cost is slight. For full instructions see special swine books. Dosage tables accompany the virus and serum.

All males not to be saved for breeding purposes should be castrated rather early in the suckling period. Choose a day when the weather is neither too hot nor extremely cold. Avoid infection by flies and filth.

Weaning.—The time to wean depends upon several things: (1) The season of the year. (2) The availability of skimmilk, pastures, and other substitutes for the mother's milk. (3) Whether the owner plans to raise two litters a year from each sow. Six weeks is young enough to begin weaning and seldom should the pigs be left with their mother after eight or ten weeks from birth.

When a pig creep has been in use through the latter part of the suckling period pigs will often wean themselves, and the mother will cease the production of milk, without any definite effort to wean the pigs. Indeed this plan makes the weaning period less serious both to pigs and mother. Heavy milking sows must not have their pigs removed all at once. The pigs may be allowed to nurse once a day for a week or so. Another plan is to take away the largest pigs and leave a few small ones with her longer.

Feeding After Weaning.—Both the sow and the litter should have good pasturage after the weaning period. Give the pigs skimmilk or make a slop of semisolid buttermilk and middlings. If the pasture contains clover or other leguminous crops water may be used in the mash instead of milk. Continue this ration giving plenty of the wet mash twice a day for six weeks.

The sow, if kept on good pasturage with good water and a supply of minerals, will need very little grain except corn. Avoid feeding enough to make her very fat. Keep her in good physical condition, ready for the next breeding period.

Culling Out Poor Sows.—The good observer will note great differences between sows while they are raising their litters. Before breeding for the next litter decide definitely which sows should be removed from the herd and fattened for pork. Culling may be done immediately after weaning the litters. Put the culled sows on a fattening ration of corn with a little tankage or middlings. Force them to fatten quickly as this plan is most economical.

Never keep sows over for breeding that produce small litters;

those that produce little milk; those that eat their pigs; those that bring pigs of poor conformation.

Planning for Two Litters a Year.—A swine raiser must make careful plans if he is to produce two litters a year from each sow without injuring her. The litters should be farrowed in the mild weather of spring and fall. As a sow's gestation period is about three months and twenty days and as the suckling period is about two months, the sow may have a period of rest and recuperation twice each year. For example, if a sow farrows April first, and her litter is weaned June first, she may rest until June tenth before being rebred for the second litter. This litter should be farrowed October first, and may be weaned December first. The sow may then rest until December tenth, when she is again bred for the April first litter.

It is well for breeders to plan to have most of the sows farrow within a few weeks of each other. They will receive better care when an attendant is regularly watching for the coming litters. The pigs may be grown off together better after weaning time than if they are of widely different ages.

Choosing a Sire.—Never breed the sows to an inferior male. He should be pure bred and registered and of the characteristic conformation of the breed. He should be smooth and of very best quality as shown by skin, hair, bone, nose, face, and ears. He should be alert, walk well on his toes, should be in good physical health, and show a good constitution. He should not be too closely related to the sows as inbreeding will emphasize inferior qualities in both.

When a boar is purchased, get the registration papers with him. Feed and care for the boar as you would for good brood sows. Avoid getting him too fat and lazy. Plenty of exercise and good pasture and plenty of mineral matter, and good sanitary surroundings should give good results.

Breeding for the Next Litter.—When the time has about arrived for re-breeding of sows, watch closely for indications that they are ready. After service, the sows should be given a quiet place away from all other swine for a few days.

Growing Off the Weaned Litter.—Feed for the period following weaning has been discussed. Besides proper feed give the pigs plenty of exercise, comfortable sleeping quarters, sanitary surroundings, freedom from lice and worms, good shade, cool wallow or bathing pool in hot weather, and have good drinking water and a supply of mineral mixtures constantly before them.

Registration of Pure-bred Pigs.—The breeder must never make a mistake in parentage of litters. When they are farrowed he should mark the pigs of each litter alike. This may be by a particular notch in the ear, cut into the cartilage, of such a form that it will not be confused with accidental notches produced by the pigs. As soon as they are weaned the pigs should be registered. Get application blanks for this purpose from the secretary of the association for that breed.

In a suitable book keep a record of breeding dates, farrowing dates, numbers and names of breeding animals, and all the pedigree data which are required on the application blanks. Read the rules of the breeding association and comply fully with all.

Preparing Pigs for Show.—Showing pigs and breeding stock at fairs is for several purposes: (1) To advertise the fact that you are a breeder of pure-bred swine. (2) To actually find buyers for stock to be sold. (3) To compete for animal prizes. (4) To win in ton-litter feeding contests.

Preparation for the show should begin long in advance. Pigs farrowed the first of March stand a better chance in the fall fairs than those farrowed later. The first fall they are entered as "junior pigs," the next year they are junior yearlings. Farrowing before the first of March will throw them into a class six months older and they will have little opportunity of winning over those that are really as old as the class will allow.

Feed abundantly and with the proper ration to get the largest growth. Buttermilk or skimmilk or tankage along with grains and good pasture will give best results for show pigs and ton litters. Freedom from lice, worms and diseases must be maintained.

Handle the pigs to be shown for several weeks before showing time. (Fig. 228.) Teach them to drive a little so they can be handled well in the show ring. Use a hand hurdle and a flat driving stick. The coats of the pigs should be scrubbed frequently and dressed with olive oil or other preparations that will produce luster. When the pigs are taken into the ring they should be in perfect trim with the hair nicely brushed.

At the show stay with the pigs. Give them the very best of care and keep them in good appearance so as to make the best impression upon prospective buyers and upon judges in the show ring.

Sale of Pigs for Breeding Purposes.—When pigs are to be shown to buyers they should be put in the same condition as just described for fairs. If public sales are held prepare as carefully

as for a big show. When pigs are sold by mail orders in response to advertising in agricultural journals or newspapers, prepare the pigs for shipment by washing and dressing the hair well before they go. An important point in selling pigs is to immunize them for life soon after weaning so that buyers will be certain of securing pigs immune from cholera. When pigs are to be shipped make

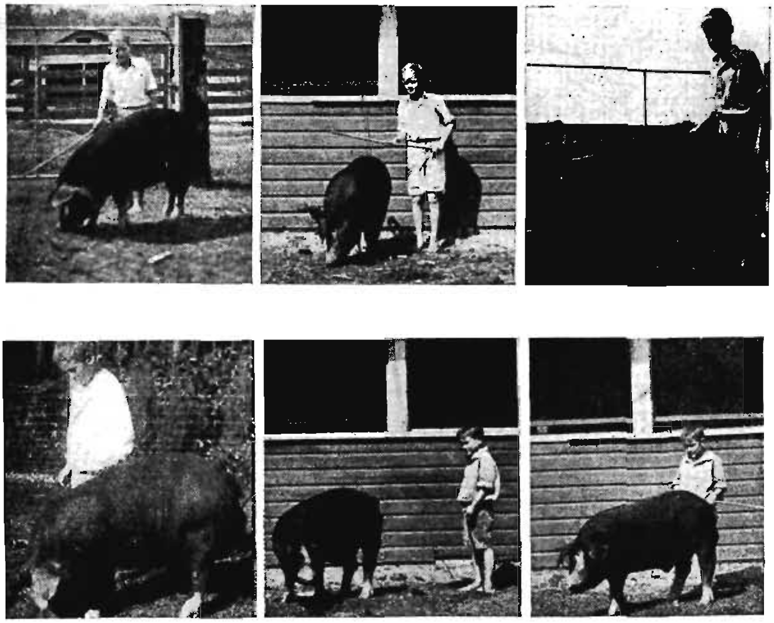


FIG. 228.—Showing pigs in the judging ring. Compare each upper view with one below it. (Florida Station.)

crates of good material and give them a coat of paint. Secure rules from the local county agent or from a veterinarian or write to the state veterinarian for health rules regarding shipment of animals. Perhaps your local express agent can show you the rules.

Selecting Gilts to Save.—Every permanent breeder should select some gilts from the best mothers with which to build up his own herd. These should be marked and removed from the rest before buyers are to come. Save enough gilts to replace the culled brood sows and to increase the size of the herd according to your plans.

Fattening for Pork.—Pigs that are of poor conformation, runts, those badly marked, and others unfit for registration should

be fattened for pork. Do not plan to keep them long. If possible they should be ready to slaughter when six or seven months of age.

The life of such pigs may be divided into four periods: (1) Six or eight weeks with the mother. (2) Six or eight weeks of pasture and wet mash. (3) Six or eight weeks on pasture with less wet mash and a little corn. (4) Four to six weeks on corn alone or corn supplemented with a little tankage or middlings. (Fig. 229.)

This plan should make the pigs weigh two to three hundred pounds when six or seven months of age.

Pigs weaned in the winter in northern states have little pasturage. Substitute cabbage and such root crops as beets, mangels

FIG. 229.—The hogging down method of harvesting corn. Mineral mixture and water are supplied in abundance. If no soybeans nor other legumes are in the field, tankage may be fed to balance the corn. (New Jersey Station.)

and wet beet pulp. A larger proportion of good milk mash will be necessary for the second period just mentioned. Constitutional troubles are more apt to be found with these winter litters because of lack of exercise. These litters, however, if fattened in time usually bring better prices than the spring litters sold in the fall.

Market Requirements.—The length of feeding period should be varied somewhat to prepare the pigs for market at a time when prices are highest. Read market quotations at least once a week to know the best weights at which to market pigs. (Figs. 230 and 231.) If highest prices are paid for pigs weighing about two hundred pounds, avoid getting them too heavy. Finish is an important element and pigs should not be sent to market in an unfinished condition. This seldom pays.

Optional Topics.—More extended studies of breeds may be made, including the historical development. Make full studies of swine troubles, such as pneumonia, tuberculosis, scours, sore mouth, thumps, rheumatism,

rickets, eczema, paralysis, lung worms, and remedies for these. Make special study of curing meats on the farm; of coöperative marketing and shipping.

Surveys, Trips, Problems, Projects, and Exercises

1. **A local survey** has been suggested. Include in this questions on

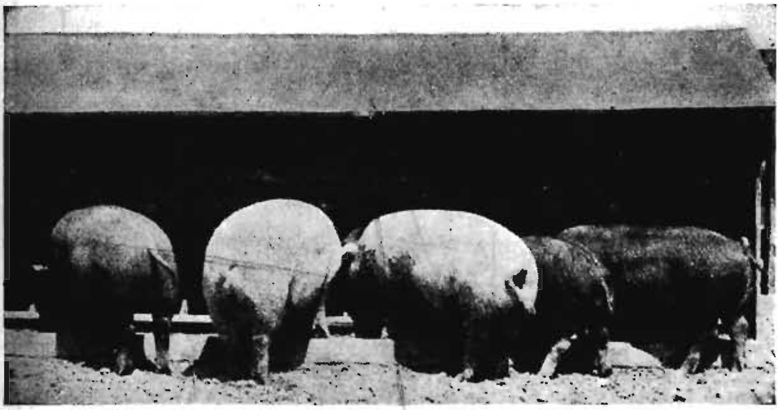


FIG. 230.—Light-weight pork production is most popular for some markets. (California Station.)

breeds, number of brood sows, number and kinds of houses, areas of pastures, crops grown, crops hogged-off, watering systems, number of litters per year, times of farrowing, sizes of litters, number of pigs raised to weaning time, rations for brood sows, rations for weanlings, special winter

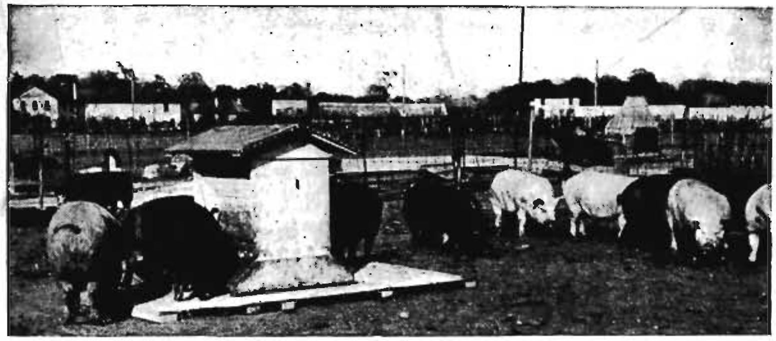


FIG. 231.—Fall pigs carried to a weight of 200 pounds using a self-feeder containing shelled corn, wheat middlings, and digester tankage in separate compartments. (New Jersey Station.)

succulence, losses from disease, inoculation, treatments for worms, treatments for lice, other treatments, number of pigs sold for breeding purposes, number sold for pork, prices, number butchered at home, type of curing. (Fig. 232.)

2. **Problems.**—(1) Calculate the average income from pure-bred herds and compare them with the incomes from grade swine. (2) Calculate the

nutritive ratio of some good rations used in the neighborhood. (3) Obtain the cost of inoculation materials and estimate the time used for inoculating. Calculate the annual cost to the farmer to inoculate all his pigs. Get numbers from the survey. (4) Compare the incomes from several farms that sell fat hogs on foot with the income if butchered and sold as cured pork.

3. **Projects.**—Read over the suggestions given in the first part of this chapter. Then outline in detail the steps, study topics, and references for such a swine project as you would prefer.

4. **Exercises.**—(1) Weigh a sample of condensed buttermilk, then dilute it to the same consistency as fresh buttermilk. Determine this by the use of a hydrometer. Determine the relative costs of the two. (2) Draw a feed record form suitable for keeping daily accounts of feed for a lot of pigs. (3) Draw a record form to use in tabulating the weights of individual pigs. (4) From a weekly market report make a graph of the best grade of pigs. Let the graph cover a period of several months. Forms for this should be secured from The Drovers' Journal, Chicago. (5) From the survey data tabulate the sizes of litters at birth and at weaning time Make graphs for each on the same sheet for comparison.

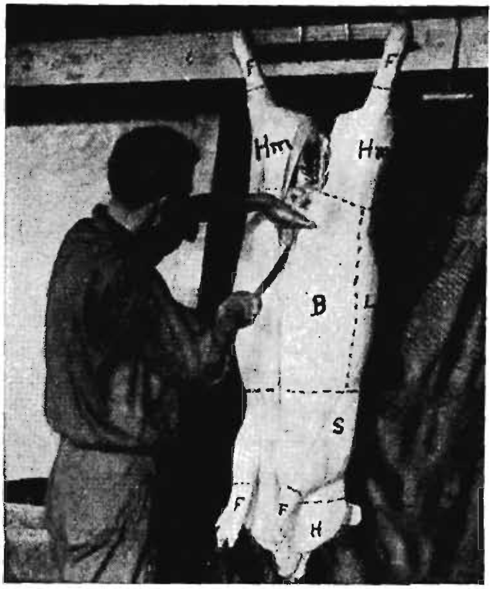


Fig. 232.—It is often most profitable to butcher and cure meats at home. Method of removing entrails. Other cuts shown by dotted lines. H, head; F, feet; S, shoulder; L, loin; B, bacon strip; Hm, ham. (New Jersey Station.)

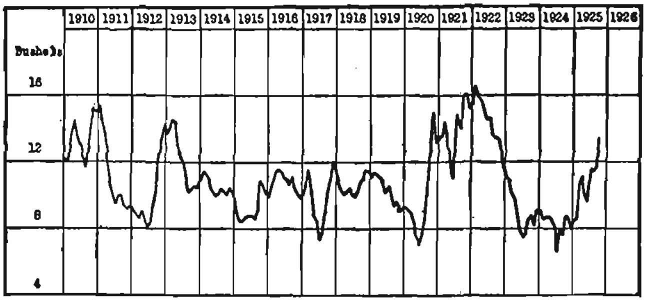
5. **Swine Charts.**—Make a chart showing the leading breeds of swine in America classified by type, colors, markings, size, ears, and snout. Another chart may show the feeds in a given growing ration for pigs and the ingredients of each: protein, carbohydrate, and fat. Make a chart showing the feed received and the gains made of a given lot of pigs on one farm or in one project. Make a calendar for one year's operations giving dates for breeding, farrowing, weaning, fattening and marketing for first and second litters.

Questions and Investigations

1. Mention four ways of beginning a swine enterprise.
2. Compare the lard and bacon types of swine.
3. List fat hog breeds. The bacon breeds.
4. Describe the Duroc-Jersey; the Poland China.
5. Describe Berkshires; Chester Whites.
6. Describe Hampshire swine.

7. Compare Large Yorkshire and the Tamworth.
8. What are the leading swine breeds of your region?
9. How would you secure stock for beginning a swine project?
10. Discuss sows *vs.* gilts for breeding.
11. Why use a score card in selecting breeding stock?
12. Discuss pure-breds *vs.* grades for breeding.
13. Discuss number of sows you would keep.
14. Give reasons for green feed for swine.
15. List suitable pasture crops for your region.
16. Give some idea of size for pastures.
17. Discuss good feeds for breeding stock.
18. Describe the making of a mineral mixture for swine.
19. Describe good houses for litters.
20. Discuss movable *vs.* permanent houses.
21. Give directions for care at farrowing time.
22. Give means of providing exercise for swine.
23. Give the elements of good sanitation.
24. Discuss lice and their treatment.
25. Explain the meaning of double treatment for cholera. Why used?
26. Give advantages of feeding pigs in a creep.
27. When should the male pigs be castrated? Why?
28. Discuss time and methods of weaning.
29. Give directions for management after weaning.
30. Tell why and how to cull out poor brood sows.
31. Outline plans for two litters a year.
32. Discuss the choosing of a good sire.
33. Give directions for registering pigs for your choice breed.
34. Give reasons for showing pigs at fairs.
35. How would you prepare them for shows and sales?
36. Give methods of securing sales for pure-bred pigs.
37. Why select additional gilts each year for breeding?
38. Give the four stages of the life of a pig which is to be used for pork; with feed for each stage.
39. What elements govern the length of final feeding period?
40. Make at home a self-feeder, an A-shaped movable house, a movable pen, a shipping crate.

Bushels of Corn Equal to 100 Pounds Live Weight of Hogs



Ratio of Corn to Pork.—The feeding of swine for profit is *dependent upon the relation existing* between the prices of feed and live pork. Corn is usually the governing feed. Prices of other feeds range somewhat with the prices of corn. When prices of

feed are relatively high, swine cannot be fed profitably. About 400 to 500 pounds of corn are needed to produce 100 pounds live weight of pork. Of course, farm conditions and the ages of pigs influence the amount of feed required.

The foregoing chart from the U. S. Department of Agriculture shows the number of bushels of corn that 100 pounds of live hogs would pay for, based on average farm prices for corn and hogs each month of the years given. When hogs are scarce and corn is plentiful the ratio becomes more favorable for hog feeders. Study the prices of corn and market hogs for a period of five years or more.

Farm Mechanics.—Make self-feeders; movable hog houses; crate for hauling; troughs; loading chute; watering devices; self oilers. Repair water system; hog houses; gates; fences. Install sanitary floors; sanitary wallows.

Calculations.—1. By following a sanitary system of raising litters of pigs with portable houses on pasture, a student with 5 litters averaged 10 to the litter at weaning time, doubling the usual number. If pigs are then valued at $5 each, find his total gain and his gain per litter.

2. In this plan this student found that during the 10 weeks on pasture he saved 40 per cent in grain feed. Allow $12 for the pasturage. Find his feeding profit due to this plan, if the old plan would have required 14 bu. grain per sow, at 60¢ per bu.

3. Two lots of pigs were fattened. The first had a grain ration only and used 601 lb. to produce 100 lb. gain, ⅛ of the pigs dead or nearly dead. The second lot had alfalfa hay added to the grain and used 418 lb. grain to produce 100 lb. gain, pigs all healthy. Find the value of alfalfa in adding 100 lb. weight to each of 21 pigs. Value grain at $1 per cwt.

4. In feeding a lot of 25 pigs starting at 150 lb. and ending at 250, a "trinity" mixture (100 lb.) was added to each 400 lb. corn. The total feed used per 100 lb. gain was 384 lb. instead of 623 lb. when corn was fed alone. Find the total saving due to the "trinity," tankage, alfalfa, and linseed meal.

5. Find the present market prices of corn per bu. and hogs per cwt. From these prices determine the corn-hog ratio or the number of bu. of corn to equal 100 lb. live weight of hogs.

DAIRY ENTERPRISE

Analysis into Jobs.—The following teaching units include the main jobs in the pursuit of a dairy enterprise. References are to pages in *New Agriculture*, Davis' *Farm Projects and Problems*, and to numbers in available *U. S. Farmers' Bulletins*. See McDowell-Field, *Dairy Enterprises*.

1. **Deciding whether or not to pursue dairying**, p. 345; *Farm Projects*, 379, 380; *Bulletins*, 1272, 1359, 1610. *Local inquiry.*—(*a*) Get farmers to compare dairying with other farming enterprises. Ask them to compare profits, labor involved, capital required and losses. (*b*) Compare local prices for dairy products with prices elsewhere.
2. **Choosing the dairy breed**, p. 345; *Farm Projects*, 380–386; *Bulletins*, 1068, 1443. *Local inquiry.*—(*a*) What pure breeds and grades of different dairy breeds are represented locally? (*b*) Find why some are more popular than others. (*c*) Ask owners to give reasons for their preferred breeds.
3. **Selecting and procuring dairy cattle**, pp. 345–353; *Farm Projects*, 387; *Bulletins*, 1066, 1068, 1443. *Local inquiry.*—(*a*) Find how and where good dairy stock can be secured. (*b*) Consult farmers regarding prices that should be paid. (*c*) Calculate the cost of raising heifer calves to milk age. (*d*) Compare the prices asked for good milkers.
4. **Planning barns, silos and dairy houses**, p. 360; *Farm Projects*, 380, 388; *Bulletins*, 578, 1214, 1342, 1393, 1643. *Local inquiry.*—(*a*) Visit several barns, silos and dairy houses. (*b*) Draw plans of those which suit you best. (*c*) Calculate the cost of each.
5. **Equipping for dairying**, p. 360; *Farm Projects*, 380; *Bulletins*, 1078, 1214, 1426, 1448, 1638. *Local inquiry.*—(*a*) Visit good dairies and make a list of all the dairy equipment you would need for your dairy enterprise. (*b*) Look up cost of these items in dairy catalogues. (*c*) Cull the list to suit the capital of a beginner.
6. **Planning rotations and pastures**, p. 358; *Farm Projects*, 389–390; *Bulletins*, 578, 1179, 1229. *Local inquiry.*—(*a*) Write out the rotation crop system followed on several good dairy farms. (*b*) Find the pasturing plans of the best dairymen. (*c*) Calculate sizes of pastures for the herds of different numbers.
7. **Feeding the dairy herd**, pp. 355–358; *Farm Projects*, 390–393; *Bulletins*, 578, 724, 1179, 1229, 1342, 1428, 1448, 1573, 1626. *Local inquiry.*—(*a*) What dairy feeds are grown on the home farms? (*b*) What supplementary feeds are purchased in your region? (*c*) Write out the dairy rations of several good feeders. (*d*) Compare these in nutritive ratio, cost and other points.
8. **Managing the dairy herd**, pp. 354, 355; *Farm Projects*, 390–393; *Bulletins*, 1412, 1470, 1600. *Local inquiry.*—(*a*) Find what dispositions are made of the male calves in your region. (*b*) Ask several dairymen to give their opinions regarding the raising of heifer calves to milk age. (*c*) How and when are the old cows culled from the herd? (*d*) Study local methods of caring for dry stock and young stock. (*e*) Study local methods of caring for milk cows in stormy weather.

9. **Controlling diseases and enemies,** pp. 360, 361; *Farm Projects,* 394–396; *Bulletins,* 666, 784, 909, 926, 954, 1017, 1018, 1069, 1422, 1536. *Local inquiry.*—(*a*) Make a list of diseases which trouble dairy herds in your region. (*b*) Find the practices to prevent and care for each. (*c*) What plans are followed regarding dehorning of cows and calves? (*d*) What testing is done to control tuberculosis?

10. **Keeping dairy records,** pp. 361–363; *Farm Projects,* 396–398; *Bulletins,* 511, 572, 782, 1182, 1272. *Local inquiry.*—(*a*) Consult Bulletin 1446 and ask several farmers to supply weights, test and feed records for their herds for one month. (*b*) Ask farmers why they do or do not keep such records regularly. (*c*) Describe the working of a cow test association to the dairymen and get their opinions regarding it.

11. **Improving the dairy herd,** pp. 351–353; *Farm Projects,* 396–399; *Bulletins,* 1167, 1412, 1532, 1604. *Local inquiry.*—(*a*) How do local dairymen cull out their poor producers? (*b*) Inquire regarding the production records of dams of bulls. (*c*) Ask farmers regarding the influence of a sire from a dairy producing mother.

12. **Producing clean milk and preparing it for market,** pp. 363–366; *Farm Projects,* 399; *Bulletins,* 602, 1315, 1359, 1675. *Local inquiry.*—(*a*) Visit places where clean milk is prepared for market, compare good and bad methods. (*b*) Make a list of ways in which milk is apt to be contaminated and study how each of these points is managed locally.

13. **Making butter,** pp. 366, 367; *Farm Projects,* 400–402; *Bulletins,* 876, 1359. *Local inquiry.*—(*a*) What proportion of the milk or cream produced locally is used for butter making? (*b*) Describe best local butter making you can find. (*c*) Suggest how it could be improved if possible.

14. **Making cheese,** pp. 368, 369; *Farm Projects,* 402–403; *Bulletins,* 960, 1191, 1359, 1451. *Local inquiry.*—(*a*) Describe how local cheese makers make the different kinds of cheese. (*b*) Criticize the bad methods found, if any. (*c*) Ask dairymen to compare cheese with butter as an outlet for their dairy business.

15. **Making ice-cream.** (See dairy books.) *Local inquiry.*—(*a*) Compare good and bad methods in ice-cream making. (*b*) Profits from these forms of dairying should be compared with pure milk, butter and cheese.

16. **Marketing dairy products,** pp. 364, 365, 368, 370; *Farm Projects,* 404–407; *Bulletins,* 1078, 1359. *Local inquiry.*—(*a*) Describe the workings of a coöperative dairy association for the handling of dairy products (local association preferred). (*b*) Get opinions of farmers regarding the benefits of coöperative marketing of dairy products.

CHAPTER XXII

DAIRY ENTERPRISE

Cattle are classified according to their purposes into three main groups: (1) The dairy breeds. (2) The beef breeds. (3) The dual-purpose or general-purpose breeds.

Farming operations and projects dealing with the first group are called dairying. The term dairying is also used for operations connected with the manufacture of various dairy products, such as the preparation of bottled milk and the making of butter and cheese.

Types of Dairy Projects.—Dairy projects are therefore of several kinds. These are each based upon the division of the work as usually found on farms and in factories. This chapter must therefore deal with the several different phases of the dairying business: (1) The feeding and care of a herd of dairy cows for the production of milk. (2) The purchase of milk at wholesale. Its preparation for market as milk and cream and the sale of these at retail. (3) The purchase of milk or cream at wholesale on the butter-fat basis and the manufacture of the product into butter or the making of cheese.

The Management and Feeding of a Dairy Herd for Production of Milk

In beginning a milk production project several steps are involved. The first of these is usually the selection of the breed of cows to be used.

Dairy Breeds.—The four leading breeds of dairy cows in America are classified according to characteristics of their products: 1. Jerseys are probably more popular than any other breed and produce butter fat very economically. The globules of fat in the milk are very large and the cream, therefore, separates readily from the milk, producing very rich cream and very poor skimmilk.

2. The Holstein breed is sometimes second in popularity and and is the most popular in many sections. The milk has the lowest percentage in butter fat of any of these four breeds. The globules of fat are extremely fine and the cream therefore does not separate so quickly from the milk. It is easily digested by children. The whole milk and the skimmilk contain a larger percentage of total

solids than milk of other breeds. This milk is therefore well adapted to cheese making and for general family food.

3. The Guernsey cattle stand third in popularity. The milk is as rich or nearly as rich as Jersey milk. The globules are nearly as large but the cream is smoother and they are called the cream breed.

4. The Ayrshire cattle give large quantities of milk, second only to the Holsteins. The milk is richer in percentage of butter

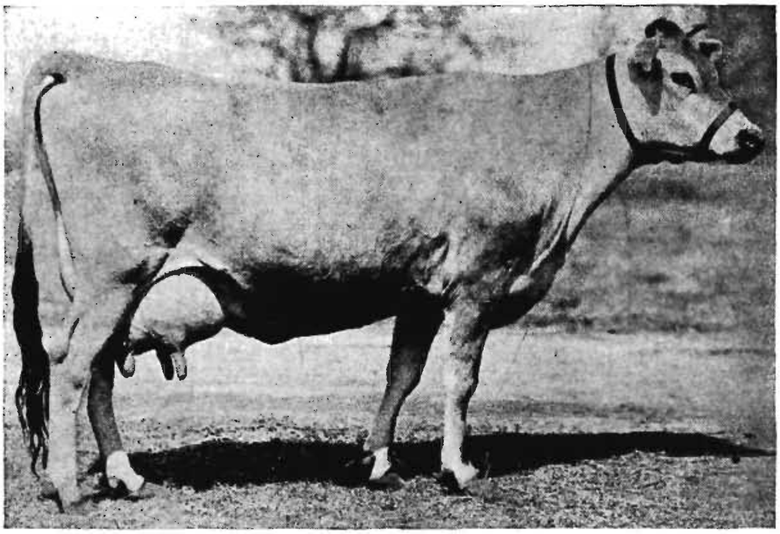


FIG. 233.—Sophie's Agnes, first Jersey to produce 1000 pounds of butterfat in one year. In that year she produced 16,212 pounds of milk. (Cornell Reading Course, Lesson 147.)

fat and is well suited to the making of cheese and as for food for children because of the small globules and high content of milk solids.

Jerseys are the smallest in size of the dairy breeds. They vary in color from fawn to red or sometimes nearly black. Black Jerseys usually have some fawn markings on the back, head, or elsewhere. Some are red or fawn with white markings. Pure-bred Jerseys always have black tongues and noses. Jerseys are in no sense dual-purpose animals. Their calves are very small at birth and bring very low prices for veal. Steers of the breed are seldom raised profitably. In quantity of milk they stand lowest among these four breeds. In percentage of butter fat they are the highest but seldom do cows of this breed hold the highest records for yearly production of butter fat.

Jerseys are usually very quiet in disposition if properly handled. Their teats are sometimes small but usually not otherwise hard to milk. They are usually sure breeders and it is not difficult to sell pure-bred calves of either sex from cows that are heavy producers of butter fat.

Guernseys are a little larger than Jerseys and somewhat similar in color but they are more commonly red or reddish with white markings. (Fig. 234.) The noses and tongues are always pink,

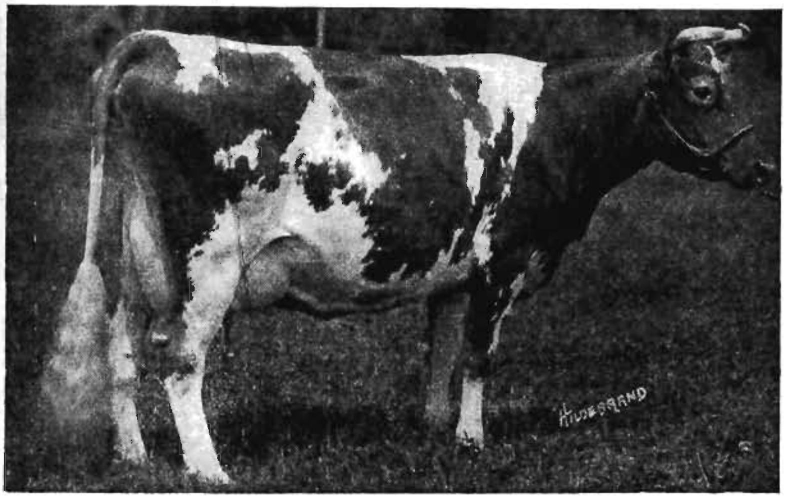


FIG. 234.—Guernsey Cow, Langwater Dairy Maid, record 16,949 pounds milk, 812.66 pounds butterfat in one year. (Cornell Reading Course, Lesson 147.)

never black, if pure-bred. The quantity of milk produced is perhaps a little greater than the Jerseys and perhaps not quite so rich. They should not be kept for beef as the steers of this breed are hardly worth feeding. The calves are a little heavier than Jersey calves at birth but when milk is of a good price the calves are not valuable enough for veal to pay for the milk they consume before slaughter. The demand for pure-bred stock of this breed is lower than for Jerseys or Holsteins, though in some sections the prices received for heifers from high-producing mothers is very satisfactory. The Guernseys seem to be better adapted to northern winters than the Jerseys.

Holstein-Friesian cattle are the largest of the dairy breeds. They are the most quiet and yet are good foragers. For many years this breed has held the world records for annual production of butter fat. Because of the size of calves at birth and the rapid

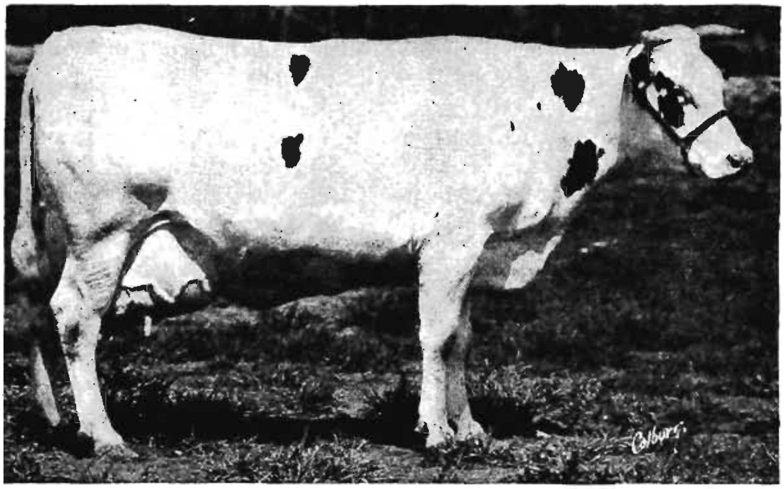


FIG. 235.—A good type of Holstein, with a record of 19,250 pounds milk and 770 pounds butterfat in 365 days. (Kansas State Agricultural College.)

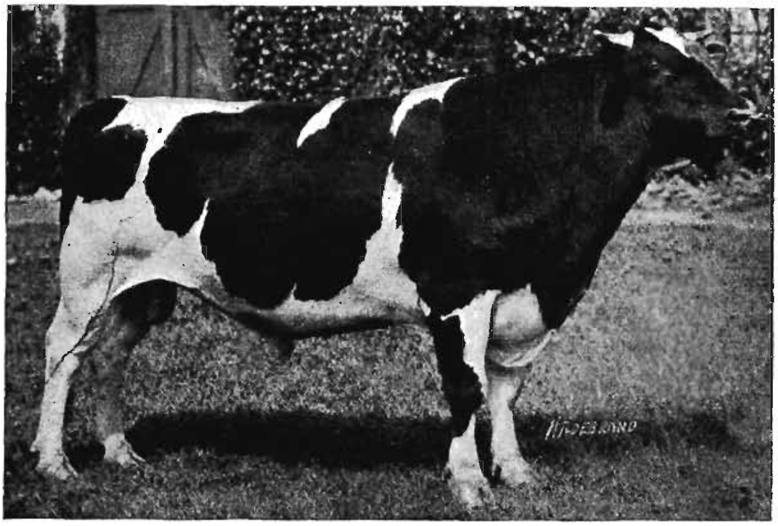


FIG. 236.—A typical Holstein bull of the darker color. (Holstein Friesian Association.)

growth during the first year they are much used for veal and beef. The calves at birth are heavier than calves of the beef breeds. In color they are black and white. Their conformation is not so typically of the dairy type as Jerseys. Because of the heavy pro-

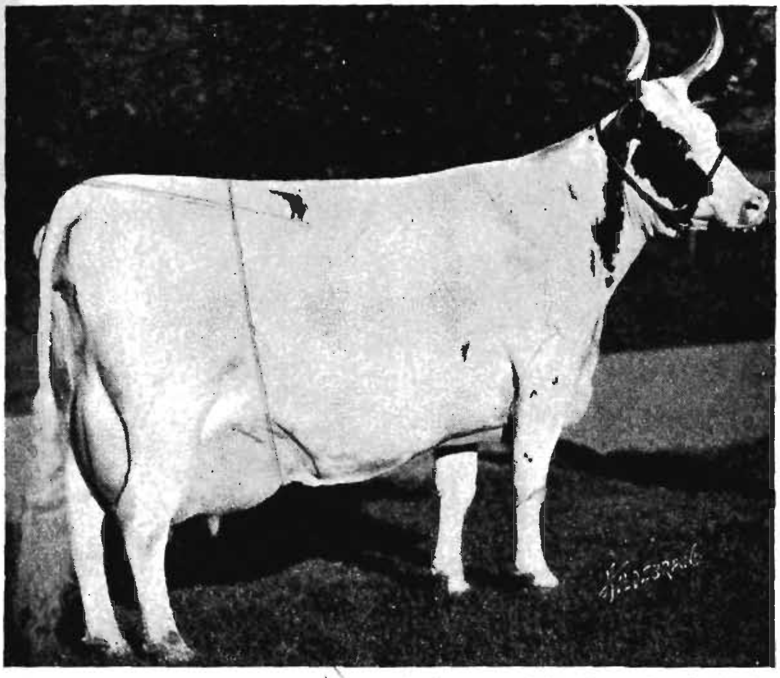


FIG. 237.—Ayrshire cow, Lessnessock Dairy Loudoun, record 17,029 pounds milk, 645.3 pounds butterfat, test 3.79 per cent. (Cornell Reading Course, Lesson 147.)

duction of milk they consume large quantities of roughage and other feed.

Ayrshires are white and brown in color. (Fig. 237.) Sometimes the white predominates and sometimes the brown. The horns are usually long, ascending and curved. They approach the Holsteins in size and quantity of milk but are less in both particulars. The calves are good for veal and the steers are worth feeding for beef. The breed is as much of the dual-purpose type as the Holsteins. In conformation many of the individuals are almost ideal in dairy type.

Other Dairy Breeds.—Besides the four leading dairy breeds just described several other breeds are used extensively for dairy

purposes: Red Polls, Brown Swiss, Shorthorn, French-Canadian, Dutch-Belted.

Milk goats are used particularly for family purposes by foreigners in the suburbs of large cities. The milk is also highly prized for invalids of certain types. It is extremely rich in butter fat.

Starting a Dairy Herd.—The beginner should cling closely

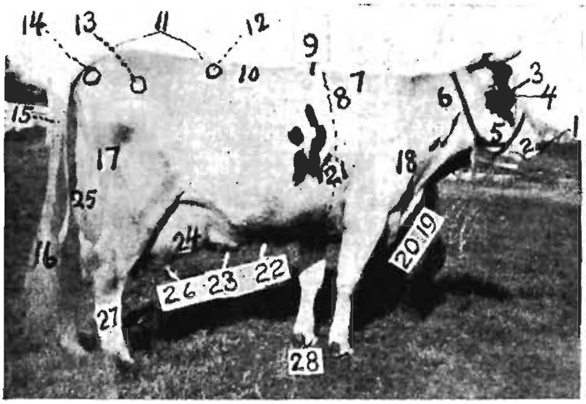


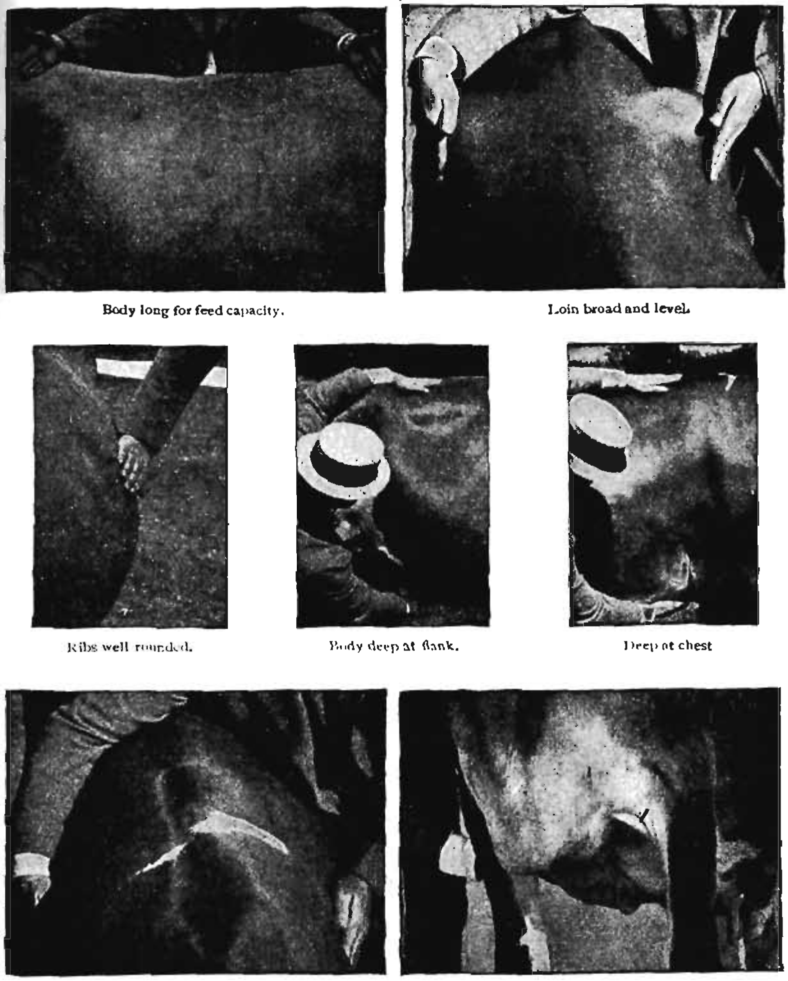
FIG. 238.—Holstein, champion butter cow of California, 1920· marked to show judging points. (California Station.)

1. Nostril, open, clear.
2. Muzzle, broad and lips strong.
3. Forehead, broad.
4. Eyes, bright, full.
5. Jaws, strong, well muscled.
6. Neck, muscular but not thick.
7. Shoulder tops, sharp, not coarse nor heavy.
8. Crops, well muscled.
9. *Chine, vertebræ open-spaced.*
10. Loin, broad and strong.
11. Rump, level, long.
12. Hip bones, broad between joints.
13. Thurl joints, high, far apart.
14. Pin bones, prominent, far apart.
15. Tail, long, tapering.
16. Switch, full, brushed.
17. Thigh, straight or incurving, not too thick.
18. Shoulder, lean, firm, not covered with fat.
19. Dewlap, not heavy, throat clean.
20. Brisket, not coarse, prominent on some.
21. Heart girth, deep, and wide from side to side at bottom of chest.
22. Milk wells, large, numerous.
23. Milk vein, large, crooked, elastic and running well forward.
24. Fore udder, extending well forward.
25. Rear udder, full and attached high and broadly not pendulous.
26. Teats, long, evenly spaced, cylindrical in form.
27. Legs below hock and knee refined, not heavy nor coarse.
28. Pasterns, strong, upright.

to the dairy type of animal and the pure or high-grade stock of one of the dairy breeds. (Fig. 238.) Study individuals carefully before purchasing: their conformation, their blood record or pedigree and the production record of themselves and ancestors.

In conformation the dairy cows should be wedge-shaped as viewed from the side, front, and top. The milk-secreting organs count for 25 per cent in the score card. The udder should be large and wide and extend high behind. The fore udder should be full and well rounded and extend forward. The teats should be evenly placed and of good size. The milk veins extending forward

from the udder should be large, long and very crooked. The milk wells where the veins enter the body should be large. The animal



Body long for feed capacity. Loin broad and level.

Ribs well rounded. Body deep at flank. Deep at chest

Fore ribs well sprung. Floor of chest wide.

FIG. 239.—How to select a profitable dairy cow. (Quaker Oats Co., and American Jersey Cattle Club.)

should have no tendency to produce surplus flesh during milking months. (Figs. 239-241.)

In choosing animals of good pedigree take the advice of experi-

Nostrils large, lips strong.

Long level rump.

Eye large, full, placid.

Udder level, well forward, teats good size, evenly placed.

Udder large, broad and high behind.

Head rather long. Forehead wide high.

Milk veins large, crooked, well forward. Milk wells large.

For dairy temperament—openness of ribs and spine.

For quality—a fine, clean head.

A fine, loose, pliable skin.

FIG. 240.—How to select a profitable dairy cow. (Quaker Oats Co. and American Jersey Cattle Club.)

enced breeders of that breed. There are several distinct strains in each breed and the breeder must decide with the advice of others which strain he prefers. Do not mix the strains and never cross the breeds.

Dairy animals should never be purchased without knowledge

FIG. 241.—Left, Flanderine escutcheon of first order, predominant type found on Holsteins. Record of cow, 10,429 pounds of milk, 355 pounds of butterfat. Right, a Selvedge escutcheon of second order, predominant type found on Jerseys. Record of cow 7,367 pounds of milk and 291 pounds of butterfat. (Kentucky Station.)

of the production of mothers and other ancestors and the individual production of cows themselves. So many breeders are now testing their herds that a buyer has no excuse for taking inferior producers.

Always use a sire in the dairy herd from a high producing mother. The influence of such a sire will be to increase rather than decrease the production of the herd. Community breeding associations are often formed for the ownership of sires. Such an association can afford to buy a much better animal than an individual dairyman. The herds of all the members will thus be improved and the cost for each be very slight.

Dairy Herd Management.—To secure the best annual yields of milk from cows they should be bred to freshen in the fall. If well housed and fed they produce their greatest flow through the winter when milk is highest in price. Pasturage in the spring will again increase the flow and the milk period is much longer. The gestation period for cows is 280 to 285 days or a little over nine months. Plans can easily be carried out to have the cows freshen in the fall. Farm labor is cheaper in the winter than in summer and the heavy milk flow should come then.

As milk production is a very severe strain on the cow's system, she should be given a rest period for about four to six weeks each year before freshening. Heavy milkers do not naturally go dry in time for this rest. To aid in this a little of the milk may be left in the udder at each milking time toward the end. Cows may be milked only once a day or every thirty-six hours. The feed may be changed to that containing less protein, such as corn and timothy hay.

The prospective milker before freshening, should be given feed which will build up her system and cause her to put on surplus flesh. If she is of dairy type she will not get too fat at this time, but will readily use her surplus flesh in the production of butter fat. The habit of stunting cows during their dry period is bad practice. Remember that the prospective calf must have plenty of nourishment from the mother at this time. Supply sufficient protein, succulence, and mineral matter in the daily ration for both.

At Calving Time.—Some cows just before calving produce so much milk in the udder that it is necessary to draw the milk from them. Most cows do not require this. Avoid it, if possible, because of danger of her having milk fever. The udder is naturally filled with colostrum which is not true milk, when the calf is born. The young should take this milk to cleanse its own alimentary tract. If tbe attendant has robbed the calf of this colostrum a purgative should be given the calf soon after birth to serve the same purpose. Cows sometimes produce young so large as to require assistance in delivery, or they may be misplaced at birth and demand attention to prevent smothering. Cows should never be allowed to hide in woods or pastures for calving. Put the cow in a box stall or other place with plenty of room and good bedding, free from other animals. Supply her with succulent feed, with wet bran mashes and plenty of water. Her bowels should be moderately loose even if a slight purgative is required. Linseed meal with the mash will

help. The attendant should be ready to give assistance in saving the life of the calf and the cow.

After calving give the cow plenty of water, slightly warmed in cold weather. Keep feed from her for several hours. Do not disturb the pair if conditions are favorable. If the calf is to be weaned at this time remove him within the first few hours or after he has taken plenty of colostrum. He can be taught to drink milk then. The mother will miss him less than if she has formed a strong attachment to him. Weaning will, therefore, cause no interruptions in her milk flow. The cow's first feed should be a wet mash of bran and linseed meal. The bowels should still remain loose for two or three days by the use of bran and linseed meal and succulent feeds.

Milk fever is a form of birth apoplexy or paralysis which occurs at this time particularly with the heaviest milkers. The cow shows extreme pain in the udder by lying down and putting her nose toward it. She is very uneasy at first and later becomes listless and her limbs cold. The remedy is to quickly pump her udder full of sterile air at all four teats. Tie a tape about each to retain the air for several hours.

Milking.—When the calf has removed the colostrum from the udder the attendant should remove all milk as completely as possible at least twice a day. (Fig. 242.) Four milkings per day at first will be better for heavy milkers. When cows are to be tested for production three or four milkings per day regularly will cause them to produce much more. The extra labor involved is balanced by the extra production. The heaviest records are usually made in the latter part of the first month of milking. Milking should be regular and at equal intervals of time. Young cows produce less milk than older ones. They are believed to reach their prime at about five years of age.

A good milker is sympathetic with the cow. He will milk gently yet rapidly and will avoid irritating the teats and udder. The udder should be massaged considerably, yet gently. Remove every bit of milk possible each time. Modern milking machines are now quite successful and are used with many large herds.

Re-breeding.—When cows have freshened in the fall as desired they should not be re-bred until about three months later. This should bring the next calf at the season desired.

Feeding Dairy Cows.—The three chief purposes for feeding livestock are (1) the growth of the young; (2) the maintenance

of bodily heat and replacement of wastes; (3) the yield of certain products as milk, eggs, wool or the increase in weight and flesh.

The composition of the animal body and the products which it yields are a good guide to the kinds and amounts of feeds required. For all of these purposes an abundance of water and mineral matter should be supplied. The other food ingredients consist of

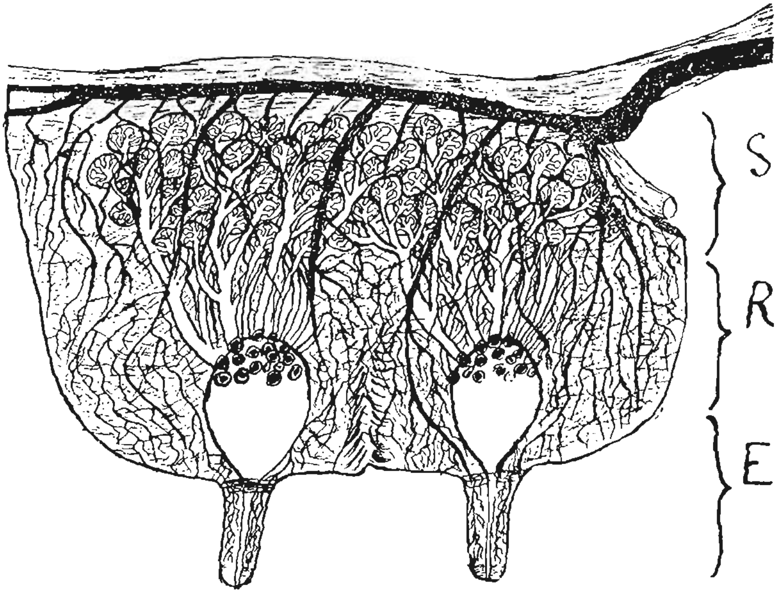


FIG. 242.—Diagrammatic cross section of cow's udder, showing the three processes that must function harmoniously together during milking; S, secretion; R, release; E, extraction. (South Dakota Station.)

(1) protein, such as the gluten in wheat, the casein in milk and cheese; (2) carbohydrates, such as starch and sugar; (3) fats as found in flax seed and cotton seed. Each animal to give the best results should have the required amount of total dry matter or feed ingredients daily.

The nutritive ratio of a feed is the relation existing between the digestible protein and the digestible carbohydrates-and-fats when combined. In a typical dairy ration, for example, a cow giving about twenty-two pounds of milk daily should have a ration in which the nutritive ratio is 5.5; that is, the carbohydrates and fat combined is five and one-half times the weight of the protein content of her feed.

To combine the carbohydrates and fats the latter is first multi-

plied by 2.25 and then added to the weight of the carbohydrates. This multiplication is for the reason that in the system the fuel value of fats is 2.25 greater than carbohydrates. Feeding tables showing the composition of the different feeds and feeding standards devised by experts for livestock of various kinds and ages are given in books on feeding. (See references.)

Roughage is a term used to include such bulky feeds as hay, corn stalks, straw and green fodders.

Concentrates include feeds that are more highly nourishing than roughage, such as whole grains and ground mill feeds. Most of the concentrates except corn are rather rich in protein. Corn contains only 6.7 per cent of digestible protein, but is very rich in carbohydrates and fats.

Balanced rations are those which supply the right amounts and proportions of each of the ingredients to supply the needs of the particular livestock in question. A balanced ration will meet the standards prescribed for animals of that kind, age and production.

Calculate the Nutritive Ratios of Feeds.—Suppose we have a ration which contains 2.22 pounds of fat, 40 pounds of carbohydrates and 9 pounds of protein. We must first multiply the 2.22 pounds of fat by 2.25, giving 5 pounds. This is next to be added to the weight of carbohydrates, 40, giving a sum of 45. This sum is next divided by the weight of the protein, 9. The quotient is 5 and nutritive ratio is written 1:5. In actual practice the feeder is required to find the number of pounds of protein and other ingredients in each of the materials used in the ration. He sets these down in the following style and from the total line calculates the nutritive ratio.

	Dry Matter	Protein	C. H. and Fat	Nutritive Ratio
21 pounds alfalfa hay	19.65	2.46	9.05	
19 pounds corn-and-cob meal	8.49	.44	6.55	
Total	28.14	2.90	15.60	1:5.38

In the feeding tables in the Appendix the carbohydrates and fat are already reduced to equivalents and given as one number. This simplifies the work. See Morrison feeding standard p. 468.

Feeding Practice.—Feed for milk cows should include succulence in the form of pasturage, silage, root crops, wet beet pulp or soilage crops cut and fed to them. The grain ration should contain a good proportion of bran, middlings, gluten feed or other mill products rich in protein. Their hay should be made from

leguminous crops as clover or alfalfa. Some other dry roughage may be given in the form of corn fodder or grass hay. Corn should never constitute the grain ration alone.

The amount of grain fed should usually be about one pound for each three pounds of milk daily. (Fig. 243.) Salt may be mixed with ground feeds to supply each cow with an ounce daily.

Pasturage.—Dairy pastures should be ample in size. In the

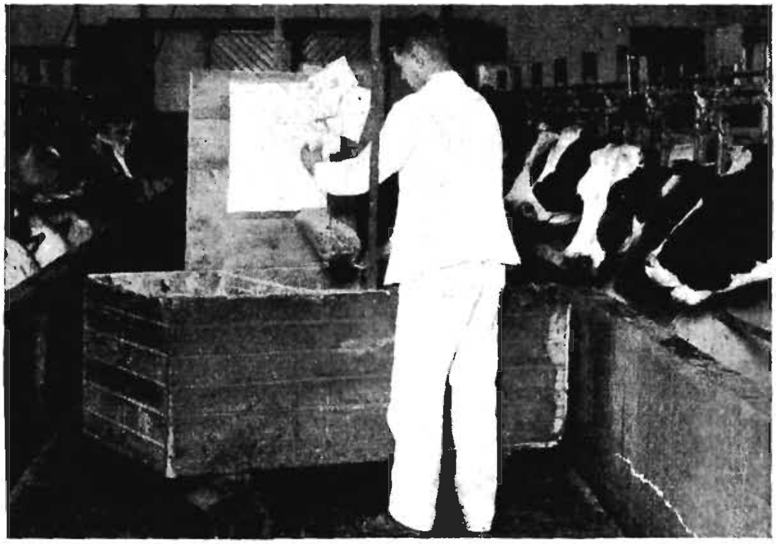


FIG. 243.—Recording the feed requirements of individual dairy cows. Scales and ecord sheet used about once a week. Other days the specified amount is measured to each ow. (New Jersey Station.)

oest growing seasons allow at least two acres per cow. If the pas-ures are poor, thin, heavily wooded or weedy, allow a larger area n proportion. Blue-grass and white clover make a good pasture nixture. In the West brome grass and alfalfa are better for dry veather. Bermuda pastures mixed with lespedeza are best for the South. Provide shade and an abundance of fresh water in pas-ures. Protection from flies is also advisable.

Soiling System.—Soiling crops are grown by the best dairy armers to be cut and fed green to milk cows. This is most impor-ant when pastures are dry in mid-summer. Field corn, cut just fter the roasting ear stage, is a good crop for this purpose.

Feeding Calves.—When milk is produced for market dairy-ien cannot afford to feed whole milk many months to calves. The

value of the milk consumed is so great that the calves will never sell for enough to pay for their feed. Whole milk is necessary for calves that are to be raised for dairy and breeding purposes. This may be supplied to them for three to six weeks and then a gradual substitution may be made by giving them skimmilk and flax seed ground and mixed with it. Whole flax seed is sometimes scalded and then mixed with the skimmilk for calves. Alfalfa hay or fine clover and legume pastures will aid greatly in their growth and development. Supply wet mashes of bran and linseed meal as soon as the calves can be induced to eat. Ground oats is also good. Keep calves growing with as little whole milk as possible.

Vitamins.—Lettered vitamins have been extensively studied. These aid growth and health of animals and people.

A, in green leaves, young stems, embryos of seeds, eggs, milk, butter, liver, kidney, and cod-liver oil. With Vitamin D it prevents rickets.

B, in yeast, spinach, whole wheat, eggs, milk, fruits, and tubers. Vitamin B_1 or F, in raw foods, tends to prevent malnutrition, as beriberi and neuritis. B_2 or G tends to prevent pelagra; it withstands cooking.

C, abundant in lemons, oranges, tomatoes, and raw cabbage. Its absence will cause scurvy.

D, in green leaves and cod-liver oil. It aids in the mineral growth of bones and teeth. Ultra-violet rays from the sun or a "sun lamp" not screened by glass have nearly the same effects.

E, in green alfalfa, cooked lean meat, and rice. It may affect reproduction in animals.

Dehorning calves should take place when they are only a few weeks old. Those that are to be killed for veal need not be treated. Feel the spot where the horn is to come through the skin. Clip the hair away in a circle the size of a silver dollar. Moisten the surface and rub it with a stick of caustic potash, held in the gloved hand. Prevent other calves from licking the spot. This is a much more humane treatment than dehorning with saws or clippers later.

Hints to Dairymen.—Avoid keeping a dog around dairy cattle. Give plenty of fresh water two or three times daily. Never have it too cold in the winter. Change the ration gradually, never suddenly. Feed hay after milking. Avoid dust while milking.

Regularity and punctuality are important elements of good dairying. Name the cows and keep their numbers and names posted over their stalls. Use vaseline on teats which tend to chap.

Learn to milk with dry hands always. Never use milking tubes if it can be avoided. Leaking teats may be treated with a little collodion after each milking. The use of alum may harden the muscle and produce some improvement. Kicking of cows is usually caused by bad treatment. Quite, gentle methods will help.

Sore teats should be cured to prevent irritation. A soft rope tied about the hocks, during milking, in the form of a figure eight, may be necessary for habitual kickers.

Do not allow calves to suck each other's ears or other parts after feeding. Pernicious habits may result. Cows that have thus acquired the habit of sucking themselves should be broken early. Try a ring in her nose and hang on this another ring or two.

When cows are stalled in barns over night keep the bedding clean and comfortable. Remember that cleanliness is the key-note of good dairying.

The Dairy Barn.—Specially constructed barns are best for dairy purposes but sheds or other buildings are often improvised for a few dairy cows. Among the chief essentials of a good dairy barn may be mentioned the following: The floor should be made of concrete for durability and cleanliness. Have a manure gutter where the stalled cows will have to stand on its edge. Have a manger on a level with, or a little higher than, the floor. Insulate the floor by a layer of tar or tar paper beneath the top coat to keep it dry and warm. Facing cows inward is better for their eye-sight and makes feeding easier. Facing them outward keeps the walls cleaner. In northern climates, barns should be warm and well ventilated with the King system of flues to prevent spread of tuberculosis and other diseases. Muslin curtains stretched over windows make good ventilators for central and southern latitudes. Have plenty of air space, about 500 cubic feet per cow. Have plenty of light, four square feet of glass per cow.

The sizes of stalls vary with breeds. The width for most milk cows is three and a half feet. Small Jerseys require a length from manger to gutter of 4½ feet. Large Holsteins require five feet. The length for others is mostly between these limits. If adjustable stanchions be used, the length may be varied to suit each cow. It is important to make her stand near the gutter. (Fig. 244.) If hay and other feed are to be stored over the main dairy room the floor should be doubled with builders' paper between the layers so that no dust can come through.

Tuberculosis in Cattle.—Most authorities agree that this disease may be communicated to human beings. For this reason milk should not be used from herds affected with tuberculosis. For the additional reason that tuberculosis greatly impairs the production and life of cattle this serious disease should be eradicated from all dairy herds. Federal and state authorities offer farmers material assistance in eradicating tuberculosis of cattle. Pure-bred

herds and some others are tested free of cost if owners will remove animals found to be infected. The tests have proved to be reliable and practically no animals are ever condemned unjustly. Herds may become accredited, *i.e.*, placed on lists of tuberculin-free live-stock, when the testing has been continued long enough to warrant it.

Tests for tuberculosis are of three kinds, subcutaneous, interdermal, and ophthalmic. The last is now considered the safest for beginners, is very reliable, and requires no special instruments. It is made by placing in the inner corner of each eye a tablet of

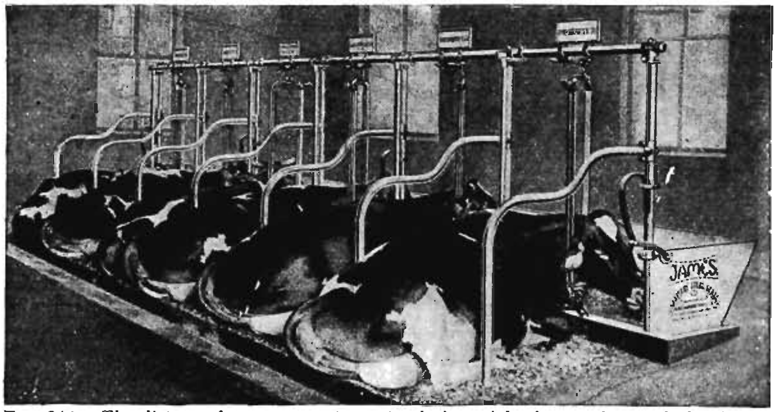


FIG. 244.—The distance from manger to gutter is just right for comfort and cleanliness. (Washburn's Productive Dairying.)

tuberculin, and holding the lids closed until the tablet has dissolved. Such tablets are inexpensive and may be obtained through supply houses. Seventy-two hours after inserting the two tablets the cow should be examined for symptoms. If pus is running from the eyes she is called a "reactor" as she has the disease. If no pus is present she is sound and free from tuberculosis.

Some Common Cattle Diseases.—Among diseases which the dairyman must prevent or combat, besides tuberculosis and milk fever, are the following: Lumpy jaw, inflammation of udder, garget, cowpox, bloat, diarrhœa (or scours), infectious abortion and hemorrhagic septicemia. Special dairy or veterinary volumes should be consulted.

Records of Production.—Every good dairyman should keep a record of the milk and butter fat produced by each cow (Fig. 245): (1) It tells him what cows may be used for increasing the dairy herd. (2) It keeps him from raising calves, now born, from

low producers. (3) It enables him to sell milk calves from good producers at higher prices. (4) It makes him a better dairyman because he is working in the light instead of in the dark.

Dairymen find that records may be kept of individual cows with less trouble than they at first imagined. Record sheets may be purchased from laboratory supply firms and from publishers of dairy journals. Place the record sheet on a board hanging on the wall of the barn. Have a pencil attached by a string to the board. Hang a dairy milk scale near it. Such a scale has an adjustable red hand, and a black hand to record actual weights. When the milk pail is hanging on the scale adjust the red hand to read zero. When the pail contains the milk from one cow it is hung on the scale and the red hand indicates the weight of the milk. This weight is recorded on the record sheet. Weighing may be sufficiently accurate if done three days in the month. The total weight of these three days is multiplied by ten for the total production of the month.

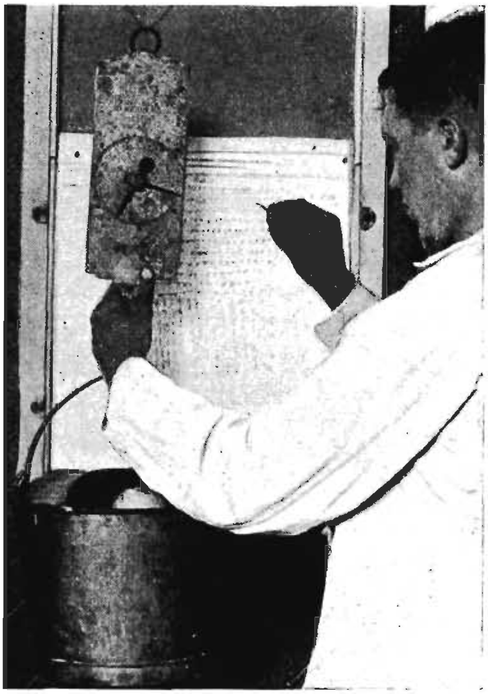


FIG. 245.—Recording the performance of individual cows. Milk scales with two hands and milk record sheet. (New Jersey Station.)

The percentage of butter fat is determined by the Babcock test using samples taken once a month from the milkings of one or two days. Just before taking a sample, pour the milk from one vessel to another at least twice. The sample is so small that it must be very true. For methods of making the Babcock test see references.

Using the Tests and Weights.—To completely determine the

cow's record for each month the total weight of milk produced is multiplied by the percentage of butter fat found by the Babcock test. This equals the number of pounds of butter fat produced in a month.

The cow's production in an entire milk period will indicate positively her value as a dairy animal. The records for the months through which she gives milk are added together. She should also be given credit for the manure produced, and for her calf. She should be charged with the feed and labor of caring for her. The charge for feed should be recorded on the sheet, month by month, because the feed varies from time to time.

Official testing of pure-bred cows is becoming more common than formerly. For each dairy breed there is a dairy testing association. Cows which make certain standards fixed by the rules of the association may be given advance registry or registry of merit. The records are officially made by supervisors sent to the herd to witness the milking, weighing, and to do the testing: most associations require that yearly tests be made up from two daily milkings and testing in each month of the year.

Producing Clean Milk.—As cow's milk is used for human food and as its nutritive qualities make it extremely valuable for invalids and children, the importance of clean methods in production and handling is evident. The essential points in the production of clean milk are given: (1) The cows should be healthy. (2) Pastures and lots should be free from marshes or stagnant pools. (3) The surroundings of barns and dairy rooms should be clean, free from vegetable and animal wastes, and well drained. (4) Barns should have the manure removed daily and the floors kept clean. (5) The inner surface of walls should be smooth and washed frequently. Water troughs should be drained and cleaned frequently. (6) Stanchions should be of painted iron or so as to be easily cleaned. (7) Ventilation should be perfect enough to remove dust from the air. (8) Windows should admit sufficient sunlight to reasonably control germ growth. (9) Swine, dogs and poultry and other animals should be kept away from milking quarters. (10) The bedding should be as free from mold and dust as possible. (11) The cows should be groomed daily to remove manure, mud and filth. (12) Long hair around the flanks and udder should be clipped closely. (Fig. 246.) (13) Udders, teats, and flanks should be washed and dried before each milking (Fig. 247); vaseline rubbed on teats and udder prevent chapping and shedding of dandruff. (14) Feed should be so handled as to pre-

vent dust in the barn at milking time; feeding just after milking will help. (15) Dirty, moldy and spoiled feeds should be avoided. (16) Hands of milkers should be washed before milking and dry hands should be used. (17) Clean unionalls and cap should be worn by milkers. (18) The milker should use clean personal habits and avoid sneezing, coughing, spitting, and should keep the fingers away from the nose and mouth. (Fig. 248.) (19) The first stream from each teat should be discarded. (20) Seven days should be allowed before saving milk from newly freshened cows. (21) Avoid using bloody or stringy milk. (22) Strainers and all utensils should be clean and scalded. (23) The dairy room for the

FIG. 246.—Hair about the udder, flanks and thighs should be kept short so it will not hold dirt. (Kentucky Station.)

handling of milk should be clean, well ventilated, light and screened; its floor should be tight and well drained. (24) No toilet rooms should be accessible to flies.

Preparing Dairy Products for Market

When milk is to be sold for direct consumption it is often in use for retailing whole milk and cream. Glass bottles are washed place either at the farm where it is produced, or may be done at a laboratory owned by a dealer or distributing agent. Coöperative marketing associations often purchase the milk from farms in large cans and do the bottling at milk depots in cities.

Bottling Milk and Cream.—Glass and paper bottles are both in use for retailing whole milk and cream. Glass bottles are washed each time by wholesale methods with motor-driven brushes and are sterilized with hot water and steam.

Milk to be bottled is first aërated and cooled to remove the volatile fats which, if kept, would soon produce disagreeable flavors. Cooling should reduce the temperature to as near the freezing point

as possible. Several types of bottling machines are in use by which milk may be rapidly bottled and capped.

In some depots milk is clarified by passing through a centrifugal machine somewhat resembling cream separators made for the purpose. *This removes some filth which passes through strainers.*

Pasteurizing milk and cream is often practised in large cities. It is heated to a temperature of about 140 degrees F. for a period of about thirty minutes; several devices have been invented for accomplishing this economically. All bacteria are not killed by pasteurization but many kinds are. (Fig. 248.) Many users and law makers believe that pasteurized milk and cream are much safer for human consumption. This is undoubtedly true so far as disease germs are concerned. Authorities have shown that heating of milk will precipitate some of the mineral content and render the milk less valuable in the nourishment of bony tissue and the balanced growth of children.

FIG. 247.—Much filth falls into milk during the milking of such dirty cows. (Illinois Station.)

Holding milk and cream.—Milk brought in cans by dairymen to city milk depots should either be held on ice from the preceding milking or should be delivered twice a day. If delivered each morning after the early morning milking the night's milk should be kept separate from the morning's milk so that the freshness is known at the milk depot. Much of this milk may come in on trains. This milk, when bottled, is usually delivered the same morning unless it is to be pasteurized. Pasteurized milk is often held until the following morning, being kept in cold storage.

In warm weather chipped ice should be used in the trays holding the bottled milk during delivery.

Marketing.—Many dairymen have their own milk routes and retail milk in bottles to their own customers. In such cases the

bottling is usually done in a special dairy room at the farm where it is produced. They may or may not purchase extra milk from neighbors. Small pasteurizers are sometimes used on farms but clarifiers are seldom found there. Farmers doing their own bottling and marketing find it necessary to keep ice during the hot weather. Cold springs aid greatly in saving expenses for ice much of the year. The term "spring house" is often used as a name for the dairy building because it is often located over a spring.

Cream Separators.—Modern centrifugal machines are used on

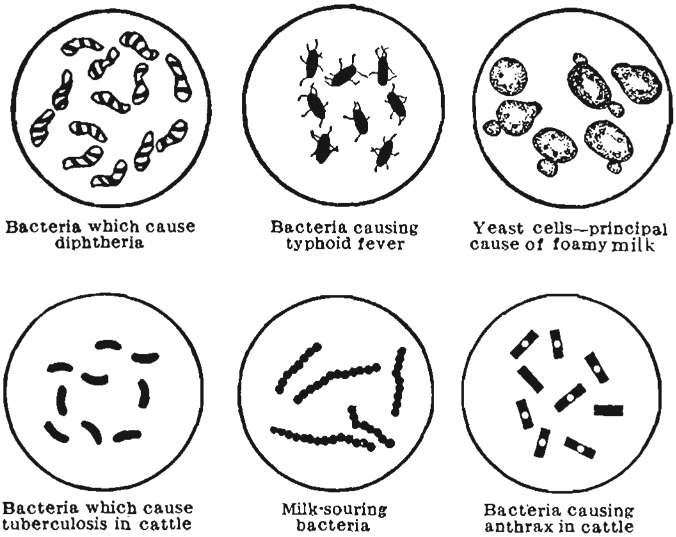


Fig. 248.—Dirty milk and cream contain large numbers of objectionable bacteria—sometimes over a million in a drop. (Kansas Station.)

the farm for skimming milk when it is freshly drawn from cows. They are run by hand or some light power, such as a small motor or a tread mill. Large separators are used at butter and cheese factories and are commonly driven by steam turbine motors. The separator may be adjusted to skim milk of any consistency desired from very thin to very thick.

Market cream is usually 20 per cent butter fat or a little more. For customers desiring cream for whipping, cream twice as rich is usually produced, called "double" cream.

Butter Making.—Most of the butter made in America is manufactured in coöperative creameries from cream brought to the factories direct from dairy farms. Some of the cream is shipped on trains. Large centralized companies are found in some states

buying cream from dairymen far and near. Formerly some of the factories received whole milk from dairymen and ran separators, but home separators are now more commonly in use and have largely replaced the old plan. The farmer now has to hold or ship cream only and usually does not take back any skimmilk or buttermilk from his factory to his farm. Tuberculosis is therefore not spread through skimmilk from one farm to another. The dairyman is required to go to the factory less frequently. Cream-gathering trucks or wagons go from farm to farm collecting cans of cream, in many intensive dairy regions.

Dairy Butter.—Many farmers run small churns in their farm dairies. These products vary widely in quality. A few produce high-grade creamery butter from their own herds and purchase some cream from neighbors. In far too many home dairies butter of very inferior quality is made and sold on the market as dairy butter. Much of this is purchased by county and village stores at low prices and allowed to become rancid and is shipped in barrels to renovators. In contrast with this appalling waste we find some dairymen making dairy butter and selling it at fancy prices to individual customers because of its high quality.

A modern butter factory is equipped with scales for weighing cans of milk as received. The cream is poured from farmers' cans into a weighing can and a sample is taken to be tested. The dairyman receives pay for the number of pounds of butter fat delivered, not for the quantity of cream. If a farmer delivers a hundred pounds of cream testing 30 per cent, he will be paid for thirty pounds of butter fat. The cream is taken from the weighing cans to a large storage vat. Different grades of cream as judged by acid test, sour taste, and odor are usually placed in separate vats. It is usually pasteurized and then ripened and churned into butter. Large churns, cream pumps and buttermilk vats are handily placed in the factory. A cold-storage room or refrigerator is used for holding butter after it is made until marketed.

Steps in Churning.—Whether butter is made in the farm dairy or in a large factory the following steps are usually found in churning:

1. Strain the cream into the churn to remove lumps and foreign matter, then add a little butter color.
2. The churn should now run steadily and slowly to cause the globules to be affected by the dashing movement.
3. Watch closely and stop the churn when the granules of butter are the size of large grains of wheat or peas.
4. Open the drain spout of the churn and strain off the buttermilk, leaving the butter in the churn in open masses.

5. Now add very cold water to rinse the butter. Turn the butter over by revolving the churn once or twice and drain off the rinse water. Repeat this again.

6. Salt the butter by sprinkling over it about one ounce to each estimated pound of butter.

7. It is usually best to work the butter in the churn enough to bring it into large masses and remove the air cavities between granules, but not enough to make it smeary or greasy in appearance. Many butter makers work it too much.

8. Mold or pack to suit the market requirements into one pound, one-half pound, or quarter-pound prints.

Overrun or overchurn are terms meaning the same thing. The reference is to the difference between the weight of butter produced by churning and the weight of the butter fat in the cream used. The careful butter maker finds that the overrun is about 20 or 25 per cent more than the butter fat purchased from his patrons. This overrun consists of water, salt, mineral matter, curd, and sugar. Butter is made up of the following ingredients for 100 pounds: Fat, 80; water, 16; salt, curd and other ingredients, 4.

The overrun in large coöperative butter factories is usually sufficient to pay all costs of operating the factory so that dairymen can receive for their butter fat as much per pound as the butter brings in the market.

Marketing Butter.—Butter factories usually seek their own buyers in large cities. Buyers consist of commission men, jobbers, chain stores, and individual groceries or hotels. Recently many butter factories in the intensive dairy states of Minnesota, Wisconsin, Nebraska, and Kansas, have coöperatively employed selling agents for the purpose of making up car-lot shipments more economically, to avoid shipping in small lots. Much of the creamery butter finds its outlet in factory cities, mining districts, railroad towns, and in southern sections where dairying is deficient.

Cheese Making.—A number of types of cheese are made in America. The most popular form of home-made cheese is called cottage cheese, which is usually made from clabbered skimmilk and sometimes from buttermilk. This is done by gently heating the milk and straining off the whey. It is then salted and otherwise flavored to suit the family or the market. Recently large quantities have been produced by factories and put up for market in paper cartons for sale by market wagons and grocers. This product must be used while nearly fresh.

Chedder cheese is far the most popular American cheese, manufactured by cheese factories and kept for several months. It is of

two general types: (1) "Full cream cheese," made from whole milk without removing the cream; (2) skimmilk cheese or skim cheese made from skimmilk in factories which use the cream for butter making. These two forms of cheese are most commonly found in grocery stores throughout the country.

Several other types of cheese are made by special factories for special market demands. The popularity of some of these is rapidly increasing. Jack cheese is one of these.

Dairy By-Products.—Butter factories have buttermilk as a by-product from the manufacture of butter. This is often sold to near-by farmers for feeding swine. Recently buttermilk condensaries have been established in several states. These purchase buttermilk from butter factories and condense it into a semi-solid form and ship it in barrels, kegs, and smaller containers to various parts of the country. It has found extensive use in feeding poultry and swine and has recently been sold somewhat to bakeries and families for human use.

Whey from cheese factories contains some albumen, mineral matter and considerable sugar. Its feeding value for swine causes the near-by farmers to use it for feeding purposes. Whey-butter is a product obtained by running whey from a full-cream-cheese factory through a cream separator to recover the lost butter fat. It is then churned with other cream into butter. Soluble albumen is a whey product recently placed on markets for use in baking.

Condensed Milk.—Milk condenseries are found in many dairy states from the Atlantic to the Pacific. Many brands of condensed or evaporated milk are marketed in tin cans in grocery stores throughout the world. Such canned milk keeps for several months, even in warm climates. The advent of this product has made it possible for travellers and people in remote sections to enjoy the privileges of milk in their diet.

"Filled milk" is a term applied to forms of condensed skimmilk in which other fats have been substituted for the natural milk fat. Some use cocoa oil from the East India Islands and some oleo fat may be used. Filled milk is believed to contain less vitamines and is therefore less suitable for feeding to children and invalids than normal milk. There is a federal law against it.

Oleomargarine is a commercial substitute for butter. This and similar preparations contain certain animal and vegetable fats inferior to butter in vitamines, which are so essential to health and growth of children. Federal and state laws are passed to curtail their use.

Milk powder is a solid powder form of milk recently extensively manufactured by several different processes. Claims are made that it will, when mixed with water, serve practically all of the purposes of normal milk. The heat used in its manufacture is believed to somewhat affect the vitamine content and this, as well as the cost of manufacture, has greatly affected its introduction.

Whole Milk vs. Butter for Market.—Many dairymen fail to compare the profits from whole milk with the sale of butter. When whole milk sells retail at ten cents per quart or more, the dairyman selling it at wholesale in cans should receive approximately one-half the retail price. Let us compare the income from 1000 pounds of milk containing 3½ per cent butter fat by these two methods of marketing: (1) If sold as whole milk to a bottling factory it should bring twenty cents a gallon, which for 113½ gallons would be $22.70 for the 1000 pounds of whole milk. (2) If 1000 pounds of milk tests 3½ per cent it should make about 42 pounds of butter including the overrun. If this be sold wholesale as high as forty cents per pound it will bring only $16.80. This makes a loss in income of $5.90, but he has saved his skimmilk, which from the 1000 pounds of milk would be about 700 pounds, which in feeding value for pigs is equal to about two bushels of corn.

Optional studies may be made including the history of each of the dairy breeds. Study also the dairy statistics for your state and for the whole country from the census reports or from dairy books.

Surveys, Trips, Exercises, Projects, and Problems

1. **A dairy survey** of the region should include the following: Number of cows of milking age; breed; grade or pure; sire; record of heaviest producers; total milk in month or week; butter fat sold; milk sold; other products sold; marketing plans for dairy products; prices for each; dairy products used on farm; dairy fats produced on farm; dairy fats purchased; estimated total cost of feed consumed monthly; records kept; yields of best cows; yields of poorest; type of silo; size; crops for filling; areas required; sizes of pastures; number of calves yearly; feeds used for calves; disposal of calves; size of dairy barn; floor; light; number of stalls; air capacity; spring house or dairy room; size; uses; testing for tuberculosis; losses from disease; treatments.

2. **Dairy problems** may be based upon project work of farmers and students and upon the data collected in the survey. (1) Compare poorest cows in the community with the best in total and net income. Calculate how many of the poor cows will be required to balance the income from fifty of the best. (2) Compute nutritive ratios of feeds in use for dairy cows and for calves. (3) Compute the monthly and annual incomes of each cow in a herd that is being regularly tested. (4) Compare incomes from milk marketed at wholesale or retail with incomes from cream sold for butter making.

3. **Dairy charts** should be made by students. Several subjects are

suggested: Characteristics of dairy breeds; steps in churning; requirements of clean milk production; chief points in dairy judging; requirements of a good dairy barn; calf feeding; dairy rations; dairy reminders; disease and remedies; records of good and poor cows compared; steps in Babcock testing; composition of milk and butter; food value of milk compared with other foods.

4. **Dairy Debates.**—"Holsteins *vs.* Jerseys for city milk market." "Holsteins *vs.* Jerseys for coöperative creamery sections." "Dairying *vs.* beef production." "Pasturing *vs.* soiling system." "Silage *vs.* root crops." "Testing and record keeping *vs.* guessing methods." "City milk market *vs.* coöperative butter factories."

5. **Dairy field trips** may be planned and taken to city milk depots, to local butter factories, to condensaries, to model dairy barns, to purebred herds, to observe silo filling, to places using milking machines, to good herds for judging practice (Fig. 249), to dairies where official and

FIG. 249.—Students selecting or judging dairy cows.

other testing is in progress, to observe the treatment of various diseases, to witness the testing of herds for tuberculosis. Students should not only oberve but should participate in operations whenever possible.

6. **Dairy projects** should be planned to cover any one or all phases of the business. They may be limited to the production side or to the manufacturing and marketing side. Refer to special dairy books in planning the steps, studies, and references.

Questions and Investigations

1. Mention three types of dairy projects.
2. Mention four breeds of dairy cattle and the special adaptation of each.
3. Describe each of these four breeds.
4. What other breeds are used for dairy purposes in some sections?
5. Describe the dairy type and its importance in choosing animals.
6. Discuss the importance of fall freshening of cows.
7. Discuss their care during the rest period.
8. Give management and feeding directions for the calving period.
9. Discuss milking for best results.
10. What are the three main types in feeding?
11. What are the three main ingredients of feed besides minerals and water?
12. Define nutritive ratio, balanced ration, roughage, and concentrate.
13. Tell how to calculate a nutritive ratio. Give an example.

14. In a book on feeding find the feeding standards for milk cows producing different amounts.
15. Give directions for feeding dairy cows; dairy calves.
16. Tell how to dehorn calves with caustic.
17. Give a number of the hints to dairymen and tell which you have seen violated.
18. Describe a good dairy barn floor including manger and gutter.
19. Compare the muslin system and the King system of ventilation.
20. Give dimensions for stalls; for air space; for light.
21. How would you plan to rid a herd of tuberculosis and then keep it free?
22. Mention cattle diseases which you have seen or known to exist.
23. Describe how to keep records of production.
24. Tell how to use the tests and weights.
25. What is meant by official testing of dairy cows?
26. Give the most important points in producing clean milk.
27. Describe the bottling of milk and cream.
28. What is pasteurization? Clarifying?
29. Describe methods of marketing whole milk and cream which you have seen.
30. Tell of the uses of cream separators. How operated?
31. Describe a coöperative butter factory.
32. Describe the relation of the farmer to this factory.
33. Give the steps in churning butter.
34. Define the term overrun. Give an example of it.
35. Describe the marketing of farm dairy butter as you have seen it. Of creamery butter.
36. Define "full cream cheese;" "skimmilk cheese;" "chedder cheese;" "cottage cheese."
37. List the common dairy by-products and give uses.
38. Define condensed milk, filled milk, milk powder, oleomargarine.
39. Discuss whole milk *vs.* butter for market.

Farm Mechanics.—Make milk stools; milk record holder; hay rack for loose stock; calf stanchions; feed cart; low wheel barrow; concrete floor. Repair tinware; cooling vat; fences; gates; manure track. Remodel old barn to make it sanitary.

Calculations.—1. Calculate a balanced ration for a 1,000-lb. cow giving 25 lb. of 4 per cent milk daily, using Morrison feeding standard and choosing common feeds from Appendix table.

2. In like manner calculate a ration for a 1,000-lb. cow giving 50 lb. of 3.5 per cent milk daily, using some other common feeds.

3. The five poorest cows in a herd averaged a production of 12 lb. of fat each per month for 10 months a year. Find the income of each cow when fat sells at 25¢ per lb.

4. The five best cows of the same herd each average 1.3 lb. of fat per day for 315 days. Find the income of each at the same price.

5. Five neighbors coöperatively buy a dairy bull, son of a high-producing dam, paying the sum of $500. If each of the five averages 25 milk cows, what is the annual service cost per cow over a period of 4 years, not counting maintenance charges?

6. Forty per cent of the calves (see above) are raised as cows, and yield $25 each per year more than their dams. Find the profit to the five men due to buying a good bull, after the first year's heifers had been producing one year.

Analysis into Jobs.—The following jobs or teaching units include the main operations in the pursuit of the beef cattle enterprise. References are to pages in *New Agriculture*, Davis' *Farm Projects and Problems*, and to numbers of available *U. S. Farmers' Bulletins*. See Snapp's *Beef Cattle.*

1. **Deciding whether or not to raise beef cattle,** p. 373; *Farm Projects*, 411; *Bulletins*, 1132, 1167, 1395, 1546, 1549, 1584, 1592. *Local inquiry.*—(*a*) Compare market prices of beef cattle with former prices. (*b*) Compare price changes with prices of feeds. (*c*) Talk with farmers regarding the hope and advisability of trying to make money from beef raising.
2. **Choosing the beef breed,** pp. 373–376, 378; *Farm Projects*, 411, 413–416; *Bulletins*, 612, 1066, 1068, Judging. *Local inquiry.*—(*a*) Which breeds are most strongly represented among the purebreds and grades of your region? (*b*) Get reasons from farmers for using the breeds they have. (*c*) Find the local conditions which would suit one breed over another.
3. **Selecting and procuring beef cattle,** pp. 373–377; *Farm Projects*, 413–416; *Bulletins*, 612, 1066, 1068, 1135, 1167, 1592. *Local inquiry.* —(*a*) Outline several plans of procuring beef cattle and get the opinions of farmers regarding each plan. (*b*) Compare the qualities of breeding stock on the best farms. (*c*) Ask successful feeders what main point to consider when buying feeding stock.
4. **Planning barns, shelters and equipment,** pp. 377, 378; *Farm Projects*, 417; *Bulletins*, 1350, 1584. *Local inquiry.*—(*a*) Visit several beef cattle farms and study the sheds and barns used. (*b*) Compare them in cost and efficiency. (*c*) Calculate the depreciation, maintenance and interest to be charged against the herd each year for barns and equipment. (*d*) Compare the barn spaces provided with the sizes of herds on several farms.
5. **Planning crops and pastures for a beef business,** p. 380; *Farm Projects*, 417–418; *Bulletins*, 1151, 1229, 1339, 1584. *Local inquiry.* —(*a*) Outline rotations followed on several good beef farms. (*b*) Study the pasture systems followed. (*c*) Compare permanent pastures with temporary pastures for beef cattle. (*d*) What grasses and legumes are used in local pastures?
6. **Buying concentrates,** p. 382; *Bulletins*, 724, 1135, 1179, 1428. *Local inquiry.*—(*a*) What grains or other concentrates are grown on local beef farms? (*b*) Ask farmers how they decide what to buy. (*c*) How do they buy needed feeds? (*d*) Get their opinions regarding coöperative buying.
7. **Registering animals,** p. 331; *Farm Projects*, 427; *Bulletin* 1167. *Local inquiry.*—(*a*) Talk with owners of pure-breds regarding ages for registering calves. (*b*) What proportion of their calves are never registered? Why? (*c*) Get them to explain their system of naming young animals. (*d*) Have them help you fill registration papers and transfer papers for each of the breeds found.
8. **Managing the herd,** p. 380; *Farm Projects*, 418–420; *Bulletins*, 1167, Breeding; 1596, Cattle grubs; 1600. *Local inquiry.*—(*a*) What systems are followed regarding the rearing of calves? (*b*) Get the dates of the dropping of calves. (*c*) Study the watering and fencing systems on several farms. (*d*) What practices are followed regarding dehorning, ringing, castrating? (*e*) Compare management of feeders with management of others on the same farm.

9. **Producing baby beef,** p. 381; *Farm Projects,* 419; *Bulletin,* 1135, Calves. *Local inquiry.*—(*a*) How many of the farmers really understand the meaning and value of baby beef production? (*b*) At what ages and weights are baby beeves finished for market? (*c*) Describe the management on local farms that produce baby beeves. (*d*) Find the ages of these animals and how they are fed during each season of their lives. (*e*) Compare market prices of baby beeves with others.
10. **Controlling diseases and enemies,** pp. 360, 361; *Farm Projects,* 421; *Bulletins,* 666, 784, 909, 954, 1017, 1018, 1069, 1422, 1536, 1596, 1625. *Local inquiry.*—(*a*) Study disease prevention on local farms and talk with owners regarding this. (*b*) Find what farmers test for tuberculosis and get opinions of others regarding this. (*c*) When do farmers treat for blackleg and other diseases?
11. **Showing and selling breeding stock,** p. 382; *Farm Projects,* 423–424. *Local inquiry.*—(*a*) Describe how cattle are prepared for show and for auction sales. (*b*) Collect sales catalogs and study how they are made. (*c*) Talk with farmers regarding the value of showing at fairs. (*d*) Ask them to compare private sales with auction sales.
12. **Wintering calves, yearlings and breeding stock,** pp. 377, 381; *Farm Projects,* 419, 420. *Local inquiry.*—(*a*) Ask beef farmers regarding the care of cattle in winter. (*b*) Into what grades or groups are cattle sorted during winter? (*c*) Find what special management is given for each.
13. **Feeding beef cattle for market,** pp. 377, 378; *Farm Projects,* 423, 424; *Bulletins,* 578, 724, 1179, 1229, 1395, 1415, 1549, 1653. *Local inquiry.*—(*a*) Describe local systems of finishing beef cattle for market. (*b*) Study the proportion of roughage and concentrates at different periods of feeding. (*c*) Find how feeders time the finishing periods to meet favorable markets. (*d*) Ask farmers about each of the feeding points mentioned under the head "Council in the Feed Lot."
14. **Marketing beef cattle,** p. 382; *Farm Projects,* 425–426; *Bulletins.* 1415, 1502. *Local inquiry.*—(*a*) Find what months of the year beef cattle are sold from your region. (*b*) Compare the market prices in those months with other months. (*c*) Get opinions of farmers regarding advisability of changing the marketing time.
15. **Butchering and running "Beef Ring,"** *Bulletin,* 1415. *Local inquiry.*—(*a*) Get opinions of people in your region regarding the value to them of a "beef ring." (*b*) Try to choose a good manager and butcher for a community beef ring and get their opinions regarding a ring. (*c*) Find how many in your community have refrigerators which would keep meat a few days.
16. **Keeping records,** pp. 18, 19; *Farm Projects,* 32, 35, 78, 79; *Bulletins,* 511, 572, 782, 1182, 1564. *Local inquiry.*—(*a*) Ask farmers what monthly records should be kept in the beef business. (*b*) What other items should be entered less frequently? (*c*) Get several farmers to help calculate cost of producing beef for market.

CHAPTER XXIII

BEEF CATTLE ENTERPRISE

THE best regions for beef production of the most finished type are found in states of the corn belt and tributary to the largest beef-packing centres. Other forms of beef production, such as the breeding and pasturing of animals, ready for finishing, are found in the western and southwestern states. The mountainous regions of eastern and southeastern states are also well adapted to this purpose.

Choosing the Breed for Beef Production.—The three leading beef breeds are Shorthorn, Hereford, and Angus. Minor beef breeds are Polled Shorthorn, Polled Hereford, and Galloway. Red Poll and Devon breeds are of the dual-purpose type, and are much used for beef production.

Shorthorns or Durhams (Figs. 250 and 251) are the most popular and the heaviest of the beef breeds, the standard weight being 1400 to 2000 pounds. The color may be white, red, or roan. The horns are small and short. Two types of Shorthorns are produced, one strictly for beef purposes and the other of the general-purpose or dual-purpose type, often used in dairy regions. They are both registered in the same herd books. Purchasers must become familiar with the different Shorthorn families before investing. The Bates strains are more used for milk production.

Shorthorn beef cattle closely approach the ideal beef type. The back is broad and straight and the ribs long and well sprung. They have large digestive capacity and good girth back of the fore legs. The loins are broad and the rump long and level. The thighs are long, thick and deep. The legs are short, showing clean bone and strong joints. The cattle are usually gentle under good treatment.

Hereford cattle (Fig. 252) are commonly known as the white-faces. The body is red; white parts are the face, back of neck and withers, under line, legs below knees and hocks, and switch. This is one of the heaviest breeds and is very popular in beef markets. They are well adapted to grazing and are more popular on western and southwestern ranges than the other beef breeds. They are of good beef conformation, having strong, straight backs. The ribs are well sprung and long; giving good digestive capacity.

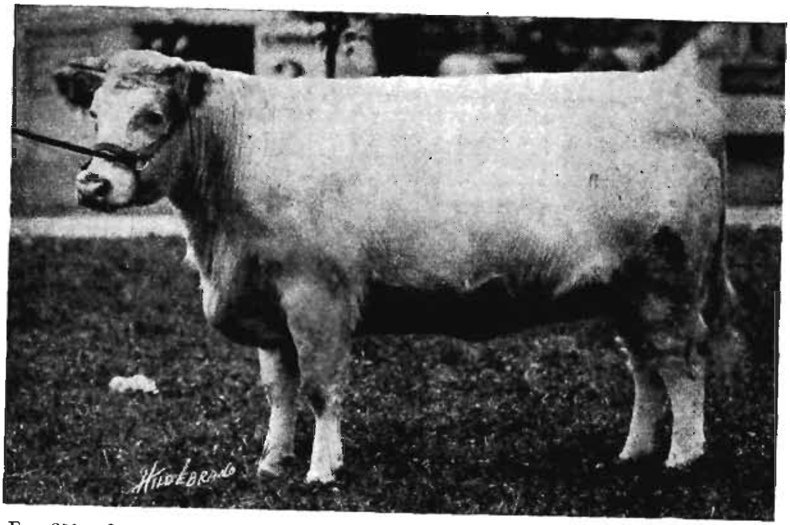


FIG. 250.—Grand champion shorthorn female at Michigan State Fair. (American Shorthorn Breeders' Association.)

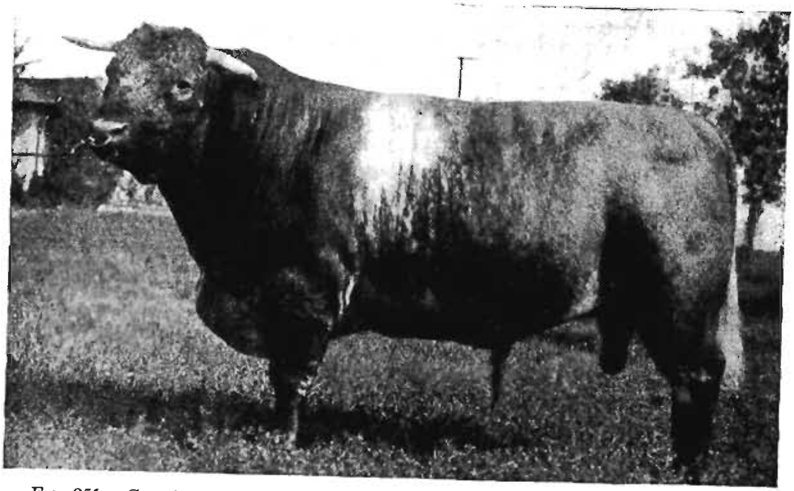


FIG. 251.—Grand champion shorthorn bull, showing characteristic form for the breed. (American Shorthorn Breeders' Association.)

FIG. 252.—Pure-bred Hereford yearling heifer. (P. J. Tinsley, breeder, Tennessee.)

FIG. 253.—Two-year-old Angus baby beef. (Minnesota Station.)

The loins are well developed but the rump often lacks evenness and levelness desired in finished beef cattle. Lightness in hind quarters is a weakness sometimes found. They develop rapidly while young and are good for the production of baby beef. The males are much used for crossing with native herds of southwestern states because of improving them rapidly.

Aberdeen-Angus or Polled Angus cattle (Fig. 253) are black and hornless. In average weight they range a little lighter than Herefords. The bodies are typical in beef conformation. In many examples the thighs are rather thin and the rumps sloping, but the back is usually good and the ribs are well sprung. Packers claim high quality for the meat of this breed and the prices are equal or slightly higher per pound in competitive sales of highly finished cattle.

The Angus cattle develop rapidly and are probably the most popular breed for baby beef production. They are most used in sections where intensive feeding is practised and have never become so popular with western cattlemen as the Herefords. When used for crossing with grade cattle the black color and beef type persist in the offspring.

Minor Breeds.—*Polled Shorthorns* and *Polled Herefords* are both hornless offshoots from beef breeds already described. Galloways are black, hornless cattle with long, shaggy coats. They are smaller than Angus and less ideal in conformation.

The *Red Poll* is truly a dual-purpose animal much used for both beef and milk. It is red and hornless.

Devon cattle are of the dual-purpose type, are red in color, and have curved, up-turned horns with black tips. They are lighter than any of the true beef breeds but are rather smooth and of fairly good conformation for beef production.

Four types of beef production are more or less clearly differentiated in America. (1) Breeding cattle of the beef breeds as foundation and improvement stock for other producers. (2) The production of cattle to be developed, and finished by others. (3) The finishing of baby beeves or other light beeves. (4) The developing and finishing of heavy beeves. Stockmen may follow one of these lines only or may combine some of them.

Farm conditions for beef cattle should be adapted to the type of production to be followed. For pure-bred herds good grazing facilities are necessary. The pastures should be of good blue-grass or other tame grasses, with good water and shade. In a shady place in the pasture, should be located a feed bunk or self-feeder so that

feeding grain to grazing animals will be possible when pastures are dry or when animals are to be prepared for shows or for sales. Winter barns should be comfortable, with conveniences for feeding and watering. The roughage and perhaps the concentrates should be either home grown or easily obtained. A silo is a valuable part of the equipment.

Producing stockers and feeders are two lines of beef production suited particularly to regions where pastures and ranges are large but where grain for feeding is expensive. *Stockers* are

FIG. 254.—Feed lot for beef cattle showing substantial feed bunks, and windbreak. The cattle are more contented when dehorned. (U. S. D. A.)

cattle considered too young, or otherwise not in condition to feed and finish for market at that time. They are usually to be kept over another season on pasture. Fodder, hay and silage should be available for wintering them over. Shelter to suit the climate will be needed in the winter. *Feeders* are cattle ready to go to the feed lot to be finished for market.

Developing and Finishing.—For production types three and four, the developing and finishing of cattle for market, some grazing may be necessary, but, most important of all, conditions must be favorable for economic, intensive feeding. (Fig. 254.) This is usually in a corn-growing section and reasonably near a good market. Farms which produce corn, other grain, clover hay, and other forage, can make use of these in feeding beef cattle. Shelters should be ample to keep the cattle dry and well protected from cold winds. (Fig. 255.) The feed lots should be well drained to

prevent mud in winter. Dry forage racks, feed bunks, and water tanks must be convenient and platforms are sometimes advisable under each of these. Tanks should be protected from freezing by boxing these in and by use of heaters in the coldest climates. Have gates and racks conveniently placed for the easy feeding of roughage and grain from wagons.

Deciding on the Breed.—In deciding which breed of cattle to use in the growing of pure breds for sale, the stockman must be governed by the demand in the region where his stock must be sold. If the region is provided with an abundance of cheap grazing

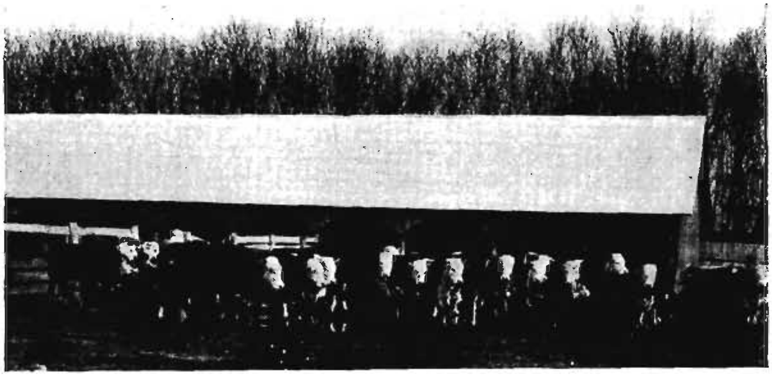


Fig. 255.—Suitable shelter for winter feeding of beef cattle; grade Hereford steers. (U. S. D. A.)

he would probably have greatest demand for Herefords or for Shorthorns. If the region is one of more intensive farming, then Angus or Shorthorn cattle will be wanted. Do not attempt to produce cattle of a breed which you do not like. Do not become a pure-bred cattle raiser unless you have a personal liking for that side of the business. If you believe that there are already enough breeders of pure-bred cattle in your section to supply the demand you should not attempt to produce more of them. After deciding all these points, if you prefer one particular breed, then choose the very best individuals within your reach—the best blood lines, and the best in conformation.

Producing Stockers and Feeders.—Cattlemen who plan to produce cattle for others to develop or finish for market, should be very careful to start with breeding stock of typical beef conformation and very high quality. Use a beef cattle score card to aid in making selections. The blocky form, strong, straight back; well-sprung ribs; fine bone; short legs; deep body; level, broad rump;

large hind-quarters; short, thick neck, and small head should all be considered closely. Quality is indicated by soft coat, pliable skin, clean bone, firm, even flesh, and smoothness. (Fig. 250.)

Beef cows should be chosen that are true to type, give promise of producing enough milk to raise their calves and are true breeders. To be sure of the last point it is well to purchase pregnant cows or those with calf at foot. When purchases are made at public or private sales choose cows which are suckling calves and are again re-bred. The cows for this herd should, if possible, be very high grades of the beef breed which will most likely suit buyers. Avoid using grades of a dual-purpose breed for this purpose.

Fig. 256.—These steers are not of good feeding type, and their gains would be unprofitable. (Florida Station.)

The Value of a Good Bull.—The breeder of beef cattle must realize the value of a good bull of the very best beef type. He should be registered and bear the characteristics of his breed. Never choose a small bull of poor conformation and coarse quality. The bull may be made to pay for his keep and a good interest on the investment by using on herds of the region. When so used the sire will soon pay for himself. Calves from a good, pure-bred sire are valued at fully five dollars apiece more at birth than others. The herd will constantly improve if a good bull is used.

Buying cattle to develop or to feed requires much judgment. If cattle are not of good beef conformation they will not make proper growth nor gains in flesh and the feeder may lose by keeping them. (Fig. 256.) Form and quality must be carefully considered. Animals of the beef type use feed more economically in the production of beef. Uniformity in size, form, quality and color should be considered in selecting the herd for feeding. Station trials show that tenderness and quality of meat vary among cattle of the same breed, feed, and treatment.

The term canner is applied to cattle of poor quality, as old cows or thin steers, not suited for beef nor for further feeding. Never make the mistake of keeping these in a lot with a bunch of feeders.

Dual-purpose cattle should seldom be selected for beef production. They will never attain so high a degree of finish. The quality makes the price per pound lower. The percentage of dressed meat is less and the cost per pound of gain is greater. Dual-purpose cattle are most valuable in dairy sections. The chief argument in the mind of the dairyman for keeping a dual-purpose breed is that the calves will bring more when sold for meat than dairy calves. As one-half the calves are males and most of these must be used for meat, this argument appeals strongly to some dairymen. However, a heavy producing dairy cow will more than over-balance the calf and milk production of the dual-purpose animal.

Care and Management of Breeding Herd.—Calves usually run with their mothers in pasture during the first summer, and should make rapid growth on the mother's milk, good pasturage, and perhaps supplementary feeds, in self-feeders or feed bunks. They will usually wean themselves as their mothers begin to go dry. When pasturage season is over they should be placed in a good feeding lot with warm shelter. Silage is an important aid in wintering calves. The roughage supplied in racks should consist of clover or alfalfa hay to save on the grain ration. If other hays and fodders are substituted, enough cottonseed meal and other grain should be supplied to keep the calves in thrifty condition, growing well and not stunted. It is a mistake to place these calves in the same feed lot with older cattle that are being prepared for market. The cost of maintenance will be greatly increased and the calves will make less growth.

Age to Finish Cattle.—The greatest profit in beef production comes from feeding young cattle. The old rule to never keep beef cattle through the third winter, may now well be revised to never keep them through the second winter. Some exceptions may be found to this rule, but they should be rare. Prices are better for young animals, rapid gains are made with less feed, and the sizes of the cuts of meat produced suit market conditions better. Maintaining animals through winter is expensive. Every winter saved in the life of the cattle adds to the profits of the owner. Young cattle have sounder teeth, and losses from disease are less. Young cattle show less coarseness.

Baby beef production is now considered more economical or profitable than other forms of beef production under many circumstances. (Fig. 257.) Cattle weighing 800 to 1,100 pounds, one and two years of age, retaining their baby flesh, well finished for market, bring baby beef prices, higher than other prices. Calves are often bought the first fall and are fed intensively through the winter and marketed in the spring. In other cases autumn calves are purchased in the spring, and fed grain in pastures the next summer for late summer or fall markets.

Older Cattle.—When calves are wintered largely on roughage their first winter, placed on good pasturage the next summer, and then fed the second winter for beef, they are finished and ready

FIG. 257.—Baby beeves. These calves were on full feed of silage, grain and alfalfa hay for 150 days. (Kansas State Agricultural College.)

for market in late winter or early spring. This is one of the commonest and most successful methods of beef production.

Council in the Feed Lot.—Feeding bunks made in the form of wide, flat troughs should be of suitable height to avoid waste and filth.

Some roughage in racks at all times will keep the digestive tract distended and cause more economical gains in flesh. This should be of good quality and include some hay.

Have the water handy as a large fraction of all beef is water. They will drink more if the water is kept at a comfortable temperature. Salt should be handy at all times.

Be sure that the bunch of cattle in the feed lot is rather uniform in size, age, and color. Cull out any that are poor in quality or otherwise unpromising. These should be marketed separately and early.

Gains should be watched closely. Attention to individuals at

feeding time will tell the feeder which ones are off feed or making improper gains. Avoid feeding too heavy at first. Treat any that show indisposition to eat. Keep all animals gaining regularly and rapidly. Watch the droppings closely and avoid feeds which are producing bad effects. A few shoats running in the feed lot will save many wastes and bring some profit from their growth.

Rations for Finishing.—Calves being finished the first winter make rapid gains on clover hay and silage and a grain ration composed of six parts by weight of cracked corn and three parts of linseed or cottonseed meal. If alfalfa be used the proportion of linseed or cottonseed meal may be reduced a little.

Yearlings in the feed lot should be given about the same ration but substitute linseed meal for all, or part, of the cottonseed meal. If a poorer grade of roughage be used, supply more of the grain and increase the proportion of linseed meal. Toward the end of the finish period the cattle will naturally eat less roughage and restrict themselves more closely to the grain ration. The proportion of corn should then be increased.

Marketing.—Before buying a bunch of cattle to develop or to feed, market demands and usual market fluctuations should be studied, and perhaps graphed. As far as possible let these guide feeding operations. Also watch market prices closely when you have a bunch of cattle on feed. When they are finished well they bring better prices. Note the market demands for certain qualities and try to meet these. Remember that most profit from feeding and finishing comes from getting better prices per pound than animals would have brought before the final feeding period. It is not the gains in weight at this time that make the profit. Arrange to have the cattle go to market at the exact time when they will bring the best prices. If kept too long they will "eat their heads off," and no profits will result.

Coöperative marketing of beef cattle is usually accomplished with little difficulty. It is better, of course, for each feeder to have a uniform carload of his own if they are to be shipped. Buyers in central markets seldom like to bid on less than carload lots. Feeders in the same region sometimes finish their cattle in the same feed lot. This makes the bunch more uniform and better prices result.

Optional Studies.—*Study the historical origin and early development of each of the leading beef breeds. Include any of the dual-purpose breeds that are found in your region. What strains are most popular? Study symptoms of diseases and their remedies.*

Surveys, Trips, Exercises, Projects, and Problems

1. **A beef cattle survey** should be made of the region. Include these: Total number of beef cattle, young and old; number of stockers; number of feeders; number of breeding cows; the beef sire; breed of cattle kept; use of sire in community; areas of pastures; feeding in pasture; age for selling stock, stockers, feeders, finished beef; prices per pound for each; rations in the feed lot; methods of marketing.

2. **Problems.**—(1) Calculate the loss to a beef breeder if he uses a bull 200 pounds under weight and the bull affects his offspring to one-

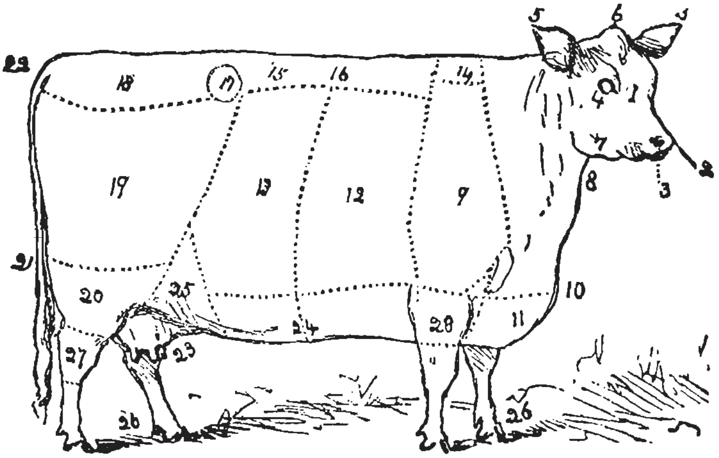


Fig. 258.—Index of descriptive terms.

1. Forehead and Face.
2. Muzzle.
3. Nostrils.
4. Eyes.
5. Ears.
6. Poll.
7. Jaws.
8. Throat.
9. Shoulders
10. Chest.
11. Brisket.
12. Fore Ribs.
13. Back Ribs.
14. Crops.
15. Loins.
16. Back.
17. Hooks.
18. Rumps.
19. Hindquarters.
20. Thighs.
21. Twist.
22. Tail.
23. Udder.
24. Underline.
25. Flanks.
26. Legs or Bone.
27. Hocks
28. Forearms.

half this extent. How many years is a sire serviceable? Estimate 100 calves per year. (2) Figure the advantages of five beef breeders coöperating in the purchase and use of a pure-bred sire costing $250 if he adds five dollar value to each calf through his breeding life. (3) Refer to feeding studies in a book on feeding to determine the quantity of feed required to feed a bunch of cattle seventy-five days. With some local herd and local prices of feeds determine the cost of feeding a herd. (4) From the weights at the beginning and end of the feeding period and the cost of feed, determine the cost for each pound of gain in weight for one animal or for a herd. (5) Compare the market prices at the beginning and at the end of such a feeding period and calculate from the weights of the cattle at these times the margin of profit gained during the feeding period. (6) Compare examples of coöperative shipping of beef cattle with shipments made through a local buyer. Calculate the differences per pound and per head.

3. **Beef Charts.**—(1) Draw an outline of a beef carcass showing the different cuts of beef and place on it the local retail price of each. (2) Make an outline sketch on a chart of a beef animal, number all of the parts of the body and under the figure give names for the numbers. (Fig. 258.)

(3) Make a list of the breeds used for beef purposes with the color, characteristics and weight opposite each.

4. **Beef Pictures.**—Collect from leading breeders and secretaries of breeding associations pictures of animals of each of the beef breeds. These should be mounted on placards or framed for use in neighboring schools and homes. Many such pictures may be obtained from sale catalogues or photographs may be taken of the animals in the region.

5. **Debates.**—"Beef *vs.* dairy production." "Angus *vs.* Herefords for beef production." "Dual-purpose *vs.* beef type for local use." "Coöperative breeding association *vs.* individual ownership of sires."

6. **Field Trips.**—Visit herds of pure-breds used for breeding purposes. Visit members of coöperative breeding associations and obtain their views regarding the plan. Study herds in different stages of the final feeding period. Take trips to abattoirs and other packing plants, cold-storage plants, shipping points, receiving stations, butcher shops and markets.

7. **Projects** in beef production may be limited to the breeding of pure-bred cattle, or the production of stockers, or the growing of feeders, or the feeding of bunches of cattle. Inclusive projects may be planned to cover several or all of these phases of the industry. It will give better training if marketing is included in each project. All steps, study topics and references should be fully outlined in advance.

Questions and Investigations

1. Mention the three leading beef breeds and three minor beef breeds.
2. Compare Herefords and Shorthorns.
3. Compare Angus and Galloway cattle.
4. What are polled breeds? Mention four.
5. Which beef breeds do you prefer? Give reasons.
6. Which breeds are found in your region?
7. Distinguish between stockers and feeders.
8. Discuss beef *vs.* dual-purpose type.
9. Stress the value of a good bull.
10. Why use a score card in selecting beef cows for breeding.
11. Describe real farms suitable for beef cattle.
12. Give several reasons for feeding young rather than old cattle.
13. Give your plans for feeding young stock for beef.
14. Give objections to the plan of carrying cattle into their third winter.
15. Enumerate points of council in the feed lot.
16. Describe good rations for finishing beeves.
17. Give marketing directions.
18. Describe the four divisions or projects in beef production.

Farm Mechanics.—Make or repair feed bunks; weighing pen; hay rack; water trough. Repair barn; fences; water system; gates.

Calculations.—1. Three students had baby beef projects with two steer calves each, of the Angus breed. They bought at the same time paying 6¼¢ per lb. for calves approximating 600 lb. each. Because of difference in feeding and management the following costs and sale prices were found:

	Walter's	Arthur's	Charles'
Feed cost, each	$32.80	$42.50	$50.60
Months fed	10	12	13
Sale price per lb.	12¼¢	10¢	9¢
Average weight each	1,020	1,100	1,150
Grain per cwt. gain	800	850	920

Find the income for each; and the net income over feed cost and initial cost of calves.

2. Find the average daily gains of each steer in problem 1, considering 30 days per month.

HORSE AND MULE ENTERPRISES

Analysis into Jobs.—The following teaching units include the main jobs in the pursuit of the horse and mule enterprises. References are to pages in *New Agriculture*, Davis' *Farm Projects and Problems*, and to numbers of available *U. S. Farmers' Bulletins*. See Gay's *Productive Horse Husbandry*.

1. **Deciding possibilities in horse and mule enterprises**, p. 385; *Farm Projects*, 429–430; *Bulletins*, 619, 779, 1167, 1341, 1419. *Local inquiry*.—(*a*) Ask farmers what influences have increased the value of horses and mules. (*b*) How many colts are produced in your region each year? (*c*) Ask their owners what aim they have in producing these.
2. **Choosing types and breeds**, pp. 385–393; *Farm Projects*, 431–435; *Bulletins*, 619, 779, 952. *Local inquiry*.—(*a*) Which types of work stock have increased or decreased in your region? (*b*) Find what breeds of horses and types of mules are most popular. (*c*) Study the breeding stock of your region as to types and breeds.
3. **Buying and selecting work animals and breeding stock**, pp. 385, 387, 389, 392; *Farm Projects*, 431, 435; *Bulletins*, 619, 779, 803, 952, 1167, 1419. *Local inquiry*.—(*a*) Ask farmers what they consider the most important points in choosing good sires. (*b*) Locate the mares in your region which are most noted mothers. (*c*) Compare these with others as to type, conformation and temperament. (*d*) What are the sources of work stock for your region?
4. **Planning barns and shelter**, p. 394; *Farm Projects*, 430, 435, 438. *Local inquiry*.—(*a*) Visit a number of barns to study stalls, floors, lighting, ventilation and cost. (*b*) Choose the type of barn which you prefer and give reasons. (*c*) Estimate the annual interest, depreciation and repairs for such a barn.
5. **Raising and training colts**, p. 392; *Farm Projects*, 30, 438–439, 441, 442; *Bulletins*, 1167, 1341, 1368. *Local inquiry*.—(*a*) In what months are colts foaled? (*b*) What care is given at foaling time? (*c*) At what ages are colts weaned? (*d*) Find practices regarding the handling of colts up to the working age. (*e*) Compare good and bad training which you find. (*f*) How many farmers have colt creeps?
6. **Feeding mature animals**, p. 395; *Farm Projects*, 437–438; *Bulletins*, 1030, 1167, 1419. *Local inquiry*.—(*a*) What methods of feeding mares with young colts are found among local farmers? (*b*) Compare local feeding of work animals with idle animals. (*c*) Compare the forms of roughage used on different farms.
7. **Caring for and managing horses and mules**, p. 394; *Farm Projects*, 431, 437; *Bulletins*, 779, 926, 1030, 1097, 1167, 1341, 1419, 1493, 1535. *Local inquiry*.—(*a*) Find the plans of farmers regarding the working of brood mares. (*b*) Find what rules are given to prevent abuse of work stock by drivers. (*c*) What changes of management are given for horses when idle or on light work? (*d*) Ask farmers for their plans regarding "turning on pasture."
8. **Maintaining health**, pp. 394, 395; *Farm Projects*, 435–437, 440, 442; *Bulletins*, 779, 926, 1030, 1097, 1167, 1419, 1493, 1503. *Local inquiry*.—(*a*) Study local methods regarding care of horses' feet. (*b*) How often do farmers examine teeth and mouths of their animals? (*c*) Ask what diseases are most common. (*d*) Talk

with farmers regarding accidents to horses and their treatment in each case. (*e*) What care is given to prevent outbreaks of contagious diseases? (*f*) Find practices regarding the cleaning of floors and walls in barns.

9. **Improving the stock,** 392–393; *Farm Projects,* 430, 435–437, 441; *Bulletins,* 779, 1167, 1419. *Local inquiry.*—(*a*) How do local owners of pure-breds improve the breeding stock? (*b*) Find their rules concerning culling. (*c*) How do they decide what animals to sell each year? (*d*) How are improved sires obtained?

10. **Marketing horses and mules.** *Farm Projects,* 440–442. *Local inquiry.*—(*a*) Talk with farmers who have sold colts or adult animals as to numbers and prices. (*b*) Find how many of these were trained for work before selling. (*c*) What advantages do farmers find in selling their surplus animals to buyers? (*d*) What attractions for buyers are found in your region?

CHAPTER XXIV

HORSE AND MULE ENTERPRISES

THE breeding of horses and mules seems now to be less profitable than formerly. The use of automobiles for pleasure and business and the use of tractors and motors for farm work have seriously affected the horse-producing industry, in recent years. Many breeders, however, find it profitable to breed horses and mules for market. Heavy draft types of horses and several types of mules are much in demand.

Selecting the Type.—There are two main types of horses, heavy and light. Dual-purpose breeds lie between these extremes. In conformation the heavy type of horse is blocky in build, low set and massive. The limbs are short and muscular, the chest being less than half as high from the ground as the withers. Great weight, particularly in the fore quarters, is important to make the animal adapted to draft purposes. The leading draft breeds with their colors, heights and weights are given somewhat in order of popularity in America:

Draft Breeds of Horses

Name of breed.	Height in hands.	Weight in pounds.	Colors predominating.
Percheron	15½–17	1800–2300	Black, gray.
Belgian	16 –17	1600–2000	Bay, black, brown.
Clydesdale	16 –16½	1800–2300	Light bay, chestnut.
Shire	16 –17	1800–2300	Light bay.
Suffolk	16 –17	1600 2000	Chestnut, bay.

Percheron horses are the most popular of the draft breeds in America. They are somewhat ideal in draft type, being massive and low-set. (Figs. 259 and 260.) The head is rather large, the nostrils of good size, the face straight, the neck short and muscular. The shoulders less sloping than in light horses. The chest should be broad and deep showing strong constitution. The back broad and short from withers to hip line. The under line of body is long, the ribs are well sprung, the form of body being somewhat cylindrical. The croup or rump is broad and wide but in Percherons is often too steep. All four legs are well muscled above

and the joints, rather broad or large. The cannons should be short and strong. The pasterns are rather upright and the feet are large

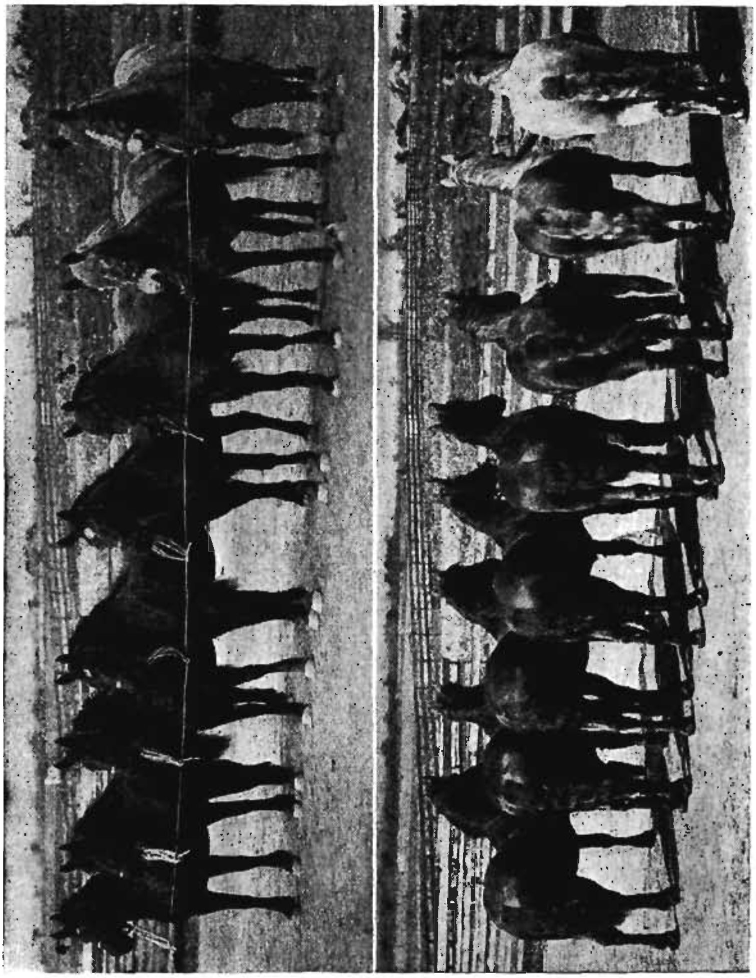


FIG. 259.—Front and rear views of eight two-year-old Percheron fillies, showing conformation. (Illinois Station.)

but not so large as in the Clydesdales. Percherons have good action in walking and trotting and show their strength well in these gaits.

Belgian horses are perhaps a little more popular than other draft breeds in some sections of America; and, on the whole, probably stand second. In conformation they are the most compact of all. (Fig. 261.) The chest is broader and the girth the greatest

of all. The rump has the objection of steepness and a low-set tail. The red and blue roan colors are sometimes found in this breed but bay, brown, and black are more popular. The legs are unusually short and are free from the feather of Shires and Clydesdales.

Clydesdale horses are popular in eastern Canada and some

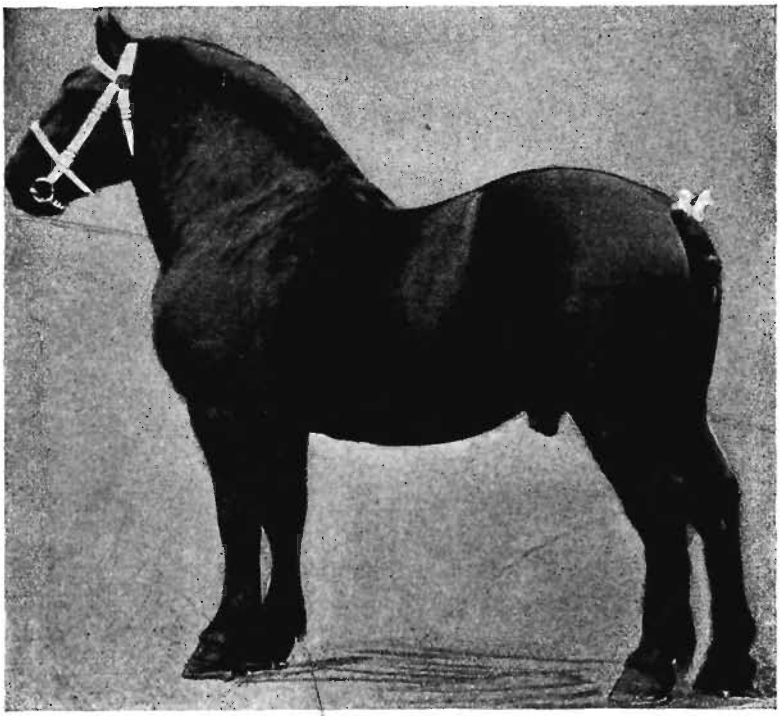


FIG. 260.—The right type of draft sire, good conformation, sound, and muscular in appearance. (W. H. Butler, of Ohio, owner. Percheron Society.)

other localities. They are quickly distinguished from Percherons in their light bay or chestnut color with white on all or some of their feet and white noses or faces. (Fig. 262.) There is much "feather" or long hair about the fetlocks, and they are noted for strength and soundness of legs and feet. Like the Percherons they are nearly ideal in draft conformation throughout. The feet are larger and the back a little more depressed. The joints and legs are often somewhat larger. The walking and trotting gaits show fine action.

Shire horses are the least popular in America of the four

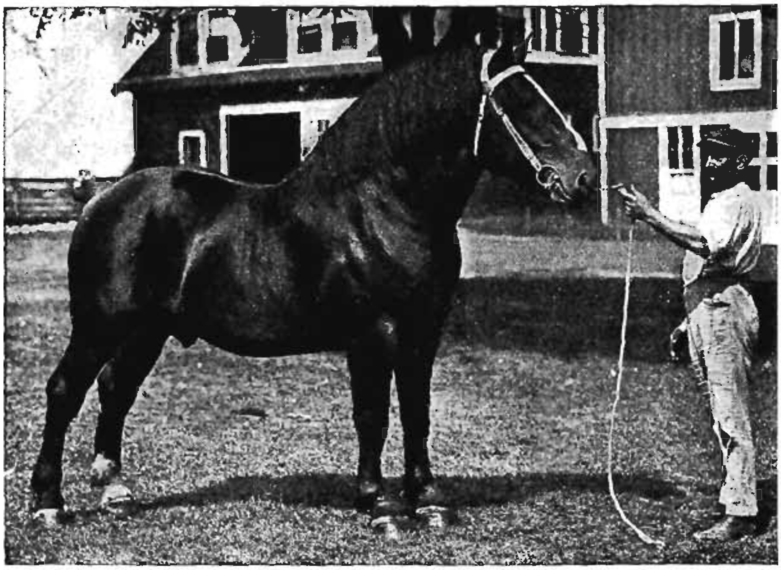


FIG. 261.—Belgian stallion showing characteristics of the draft type. (Gay's Productive Horse Husbandry.)

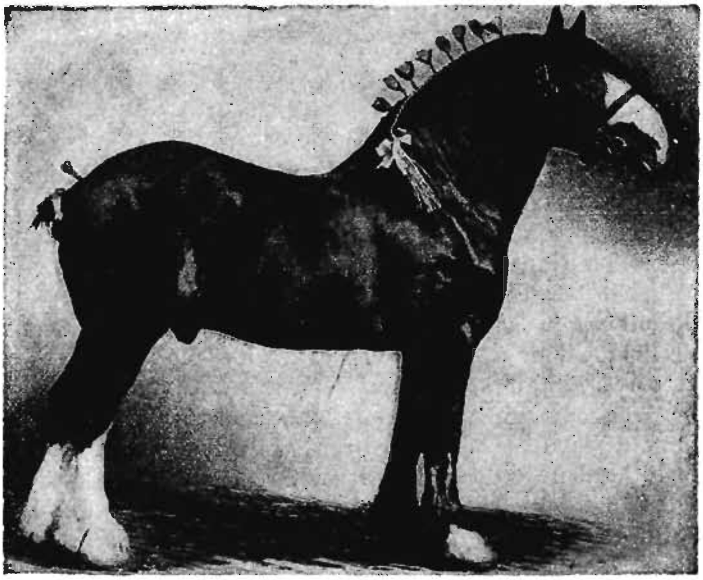


FIG. 262.—Clydesdale horse in show condition. (U. S. D. A.)

breeds mentioned. They greatly resemble the Clydesdales in color, markings, and feather of the legs. In build they seem to be a little more massive than Percherons. In action their gaits are more clumsy than either the Percherons or Clydesdales. The legs and joints are heavy and the feet large.

Coach horses are of several breeds of the heavy carriage type. They are midway between the draft and light types. Their popularity has waned with the advent of automobiles. The cab horses formerly so popular in the cities to haul medium loads at a moderate trot are large, active and stylish. They are used for general driving. The chief breeds included here are shown in the following table.

Coach Breeds of Horses

Name of breed.	Height in hands	Weight in pounds	Colors predominating
Cleveland Bay	16 –16¾	1200–1550	Bay with black points.
French Coach	16 –16½	1200–1350	Bay, brown, chestnut.
German Coach	16 –16½	1350–1450	Black, brown, chestnut.
Hackney	15½–15¾	1000–1200	Chestnut.

The Light Horse Type.—In conformation light horses are rather tall, legs long and light and the general build suited to rapid, light work. The leading breeds are given in the following table. In addition to these four the Arabian and Orloff Trotter are less popular in America. The Morgan breed has been often considered a family of the Standardbreds.

Light Breeds of Horses

Name of breed	Height in hands	Weight in pounds	Colors predominating
Thoroughbred	14 –16½	800–1100	Bay, brown.
American Saddler	15⅜–15⅝	950–1050	Bay, brown, black.
Standardbred	15¼–15¾	900–1150	Bay, brown, black.
Morgan (Fig. 263)	14¾–15¾	900–1150	Bay, chestnut.

The Thoroughbred horse is popular both in England and America. The head is of moderate size, fine and lean; the prominent eyes have an intelligent look; the ears are alert and of moderate size; the neck is long and fine; the shoulders are obliquely

sloping; the chest is deep but narrow; in height the chest is more than half the height; the body is cylindrical, with the ribs well sprung. The under line of the body is greater than the top line from withers to hip but less than from withers to tail. The rump should be long and level but not too broad. The tail should be attached at medium height and carried gracefully. The hind quar-

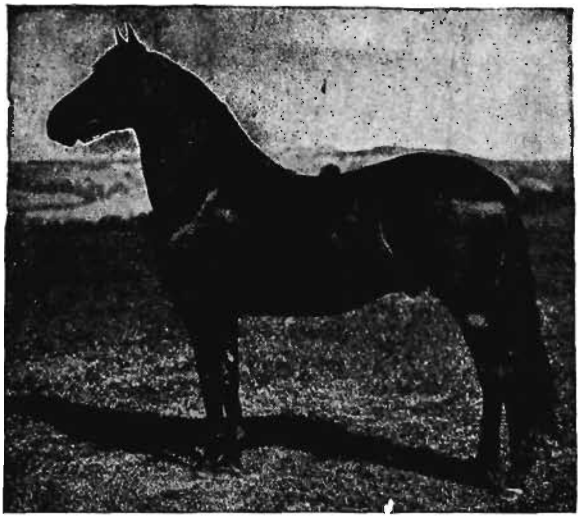


FIG. 263.—A typical Morgan horse.

ters are extremely powerful, giving strength in racing. The fore legs above the knees are also strongly muscled. The leg joints are all neat and clean and the bones clean cut. The pasterns should be sloping at about forty-five degrees. The feet should be firm, of medium size and width and high at the heel. Thoroughbred horses show good action, being free and easy in their movements.

Standardbred horses are second in popularity in America among the light breeds. The breed is often called the American Trotting breed as the horses are noted for their trotting and pacing records. (Fig. 264.) They are less trim in build than the Thoroughbreds. There is also less uniformity in the breed. The conformation is often angular and the joints and muscles prominent. The under line is very great and straighter than in Thoroughbreds. In speed and action they are characterized by long-reaching hocks and knees and quick movement of the feet.

American saddle horses (Fig. 265) are heavier in build and shorter in body than typical thoroughbreds. The head is carried

very high and the neck well arched. They show extreme style in this and in carriage of tail. They have great strength of back and loins. In action they are also stylish. The pasterns are even more sloping than in other breeds, giving extra ease and spring to the gait. A number of gaits are desirable in saddle horses and individuals of this breed are extremely delightful in this regard.

Fig. 264.—American trotter, representing the light horse type.

Ponies are very popular, particularly in certain sections of the country, and the breeding of ponies is a profitable project. The several breeds vary greatly in size and conformation. They are all, however, used for both driving and riding. In the following table five pony breeds and the Mexican and Indian groups are compared.

Breeds of Ponies

Name of breed	Height in inches	Weight in pounds	Colors predominating
Shetland	34-44	250-400	Black, brown, piebald.
Welsh	48-56	400-600	Brown, gray.
Exmoor	48-56	500-800	Bay, gray.
Arabian	Under 56	600-800	Bay, white.
Hackney	Under 56	600-800	Bay, white.
Mexican	Under 56	600-850	Duns, mixed.
Indian	Under 56	600-850	Duns, bays, mixed.

Shetland ponies, either pure or grade, are by far the most popular in America. They are easily raised, being good grazers and economical feeders.

Mules.—The mule is much used in American agriculture for field work, particularly in southern states, and is used in mines everywhere. Other forms of motive power are not likely to supplant the mule. In mule markets several classes are given: *Plantation mules,* sugar and cotton mules from well-bred mares of rather light type, the mules being quick in action and fine in bone and

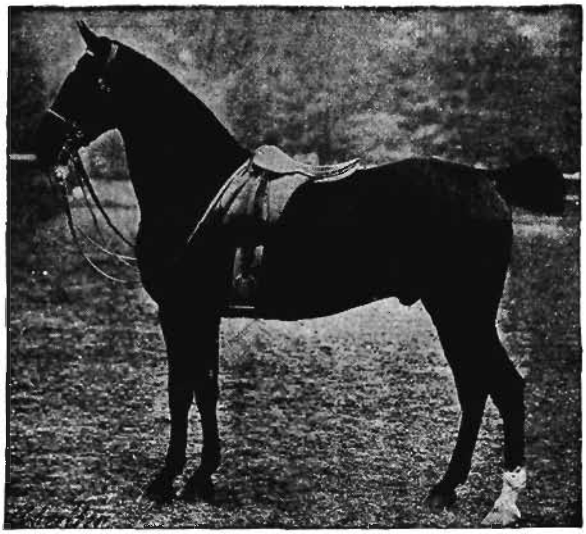


FIG. 265.—Saddle horse, showing characteristic form.

rangy in build; *mine mules and lumber mules* of two classes that are heavier and larger, produced by draft mares and big-boned jacks. Some mines require mules that are low in stature, yet heavy in build.

In comparison with the horse, the mule is less sensitive to over-feeding or under-feeding, needs less elaborate stabling, endures hot weather better, frets less and is less irritated by bad treatment, has less foot troubles, and will sell better when slightly blemished or infirm. Mare mules usually sell better than horse mules as they have better conformation and are less subject to bad habits.

In selecting mares for the breeding of mules remember that good size will add to the price of the offspring. Choose those that are of good breeding conformation, wide in rump and hips, good constitution, and with large digestive capacity. (Fig. 266.)

Jacks for mule breeding should be large and sound, with good bone. The height should be sixteen hands if possible. The more

weight the better. In color he should be black with light points, as such jacks produce uniformity of color in the colts.

Examining for Unsoundness.—Before buying horses for breeding purposes or for use, examine carefully all points for unsoundness and evidence of bad habits. Many are unsound without showing it at first. Horse dealers naturally call the buyer's attention to good points. To examine a horse for physical defects or blemishes begin while the horse is in his stable. Has he been biting or kicking the stall? Are there signs of persistent pawing? Cribbing and wind sucking and vicious kicking may be thus

FIG. 266.—Good types of mares for production of mules. (Gay's Productive Horse Husbandry.)

detected. When made to stand to the other side of the stall he may show signs of stringhalt, being unable to lift the hind foot on the affected side, or if it is lifted being unable to bring it down promptly. To test for the latter point lift the hind foot slightly forward and bend it upward, then let it go quickly. Examine in the stall for signs of the halter-breaking habit.

Now lead the horse out of doors. Begin at the head on one side and examine him from head to heels on both sides. Watch the nose for signs of colds. Swelling under the jaw may show distemper. Look for bad teeth and examine his mouth for age. What kind of a bit has he used? Wave the hand in front of each eye to detect for good sight. Are there bad discharges from the eyes? Poll-evil may be detected by pressure on the head. Are there sores and swellings there? Examine the withers, back and shoulders for signs of running sores and boils. A stumbling habit may be detected by scars on the knees. Compare right and left

limbs to detect enlargements, wind-puffs, ring-bones, bunches, curby hocks, soft or bog spavin and bone spavin. Feel just above the hoofs for ring-bones, and, at the rear of the hoof feel if the soft cartilages have hardened into side bones. Examine the hoofs and feel for cracks of any kind, signs of brittleness, scratches, contracted heels or other defects. The hoof should be of good color to show life. The frog in the centre of the sole should be elastic and well supported on the sides with braces.

Now examine the horse's gaits, walk, trot and canter. Watch for irregularities due to lameness or bad habits. Heaves and bad breathing may be shown after vigorous exercise.

Care and Management of Horses.—Regularity and watchful common sense are the best guides in the care of horses. The con-

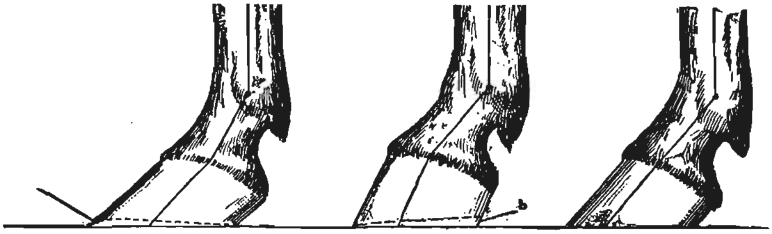


Fig. 267.—Left, a hoof with too much horn at (a), throwing the foot axis backward Centre, surplus horn at (b) throws the axis forward. Right, hoof trimmed and axis straight. (Gay's Productive Horse Husbandry.)

dition, spirit and appetite of a horse should be closely watched. Keep the coat in a healthy, slick condition by regular, thorough grooming. Give special attention to the shoulders of work horses and bathe them frequently with water of suitable temperature. When there is the slightest soreness add some antiseptic to the water.

The mouth should be examined for decaying teeth or overgrowing points and swollen gums. When a horse refuses to eat his grain determine the cause.

Have stable conditions such as to prevent horses from injuring themselves on the stalls and protect them from draughts of wind. The floor should be made to give good drainage and should be kept clean and well bedded.

The feet of the horse require much attention. (Fig. 267.) Clean out the hoofs daily to remove gravel and other materials. The structure of the hoof will then be well understood. Trim the hoofs whenever necessary to keep them in proper shape. Supply shoes to suit the kind of work and refit them when the hoofs need

trimming. The slightest lameness should be detected quickly and the cause removed. Give plenty of exercise when horses are not regularly at work.

Feeding.—A 1200-pound horse at light farm work should be given six to ten pounds of oats and seven to ten pounds of hay daily, divided into two or three feeds. At medium work give him ten pounds of oats and twelve pounds of hay. At heavy work increase the oats to twelve or thirteen pounds and offer a little more hay. When corn is substituted for the oats the same amounts of grain may be used, but the hay should be somewhat richer and contain a mixture of clover or alfalfa with timothy or other grasses. Always avoid using dusty hay for horses.

When horses are idle the grain should be reduced but hay may be given to supply his wants.

Optional Studies.—Read the historical development of each of the breeds, particularly those of most local interest. Read the story of Hambletonian 10 and the influence he had on the development of the Standardbred horses. Study the common diseases of horses and treatments.

Trips, Surveys, Exercises, Projects, and Problems

1. **Survey.**—A list of points for a local horse and mule survey should include the following: Number and kinds of work animals; types; number and type of brood mares; number of colts produced annually; kinds; jacks, stallions; number of draft horses used in the nearest town; number of saddle horses; number of horses or mules purchased during year; number sold; prices; diseases and other troubles; losses.

2. **Problems.**—(1) Compute the total income for the neighborhood from horse raising for one year. (2) Compute the total outgo for those purchased. (3) Calculate the cost of all items in raising a colt to working age. (4) Compute the annual cost of the care and management of a team for twelve months. (5) Determine the number of idle days and working days for the average farm team of the region and compare with the preceding problem to determine the average cost for each day of labor. (6) If possible calculate the cost of a tractor doing the same amount of farm work as a team in a year and compare this cost with that of a team.

3. **Debates.**—"The horse *vs.* the tractor." "Horses *vs.* mules." "The draft horse *vs.* the light horse for farm purposes." "Percherons *vs.* Clydesdales for raising pure-bred colts and mules." "Light horses *vs.* automobiles for pleasure and business."

4. **Horse and Mule Charts.**—On a chart list the breeds of horses and give the color, weights and heights of each. On another chart make a comparative table of the different market types of mules. From a special horse book make a list of common diseases with the symptoms and remedies. Make a chart of incisors of the horse to guide in detecting ages. (Fig. 268.) Copy these from a horse book. Make a chart giving the main points in the draft type and another giving the main points in the light-horse type.

5. **Pictures** of the horses of the different breeds should be collected and mounted on placards or framed for homes and near-by rural schools. Obtain these by writing to secretaries of breeding associations, prominent breeders advertising in agricultural journals, sale catalogues, fair advertisements and magazines.

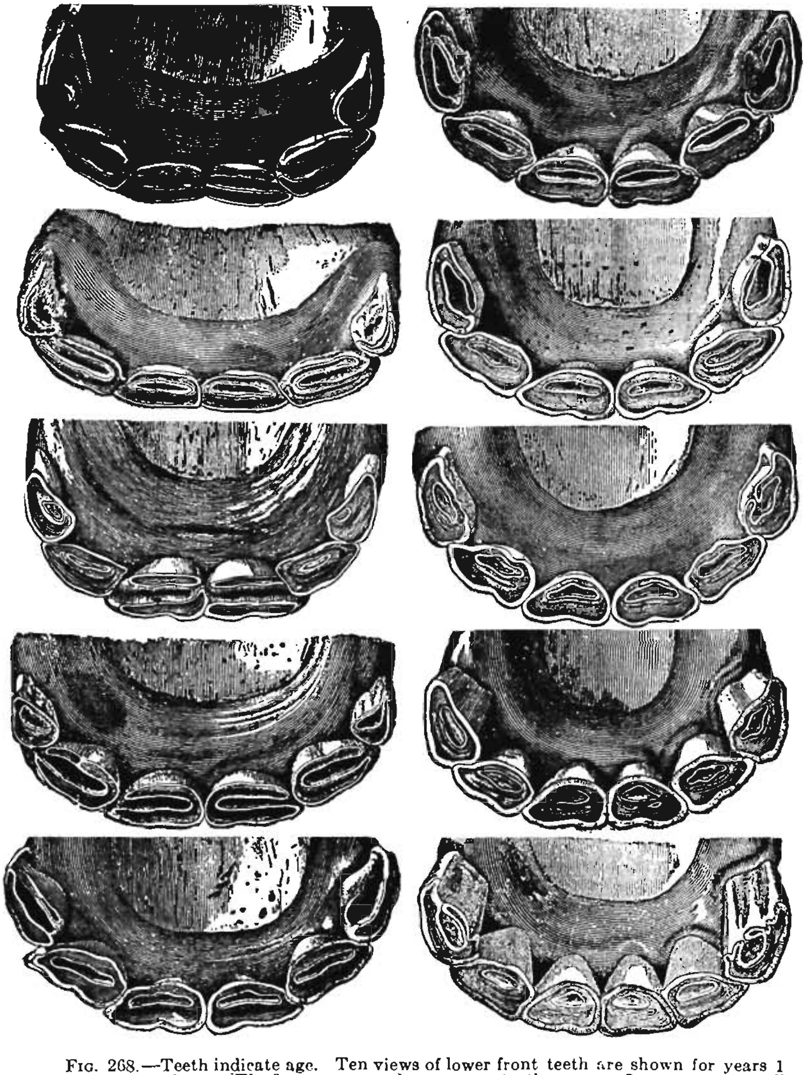


FIG. 268.—Teeth indicate age. Ten views of lower front teeth are shown for years 1 to 10, down each column. The first two central permanent teeth are up at 3, two more at 4, all up at 5. At 6 years, cups leveled on center teeth; at 7, cups leveled on intermediate teeth; at 8, all six are leveled and corners are becoming oval. More wear is shown at 9 and more at 10. Compare shapes and positions of central enamels. (Gay's Productive Horse Husbandry.)

6. **Field Trips.**—Practise judging horses of different breeds and types found in the region. Use score cards obtained from laboratory supply houses. Visit mule and horse markets and public sales to study animals of different types and learn causes for differences in price. Visit shipping points when horses are either going out or coming in. Visit stables of companies keeping a number of work animals and study their methods

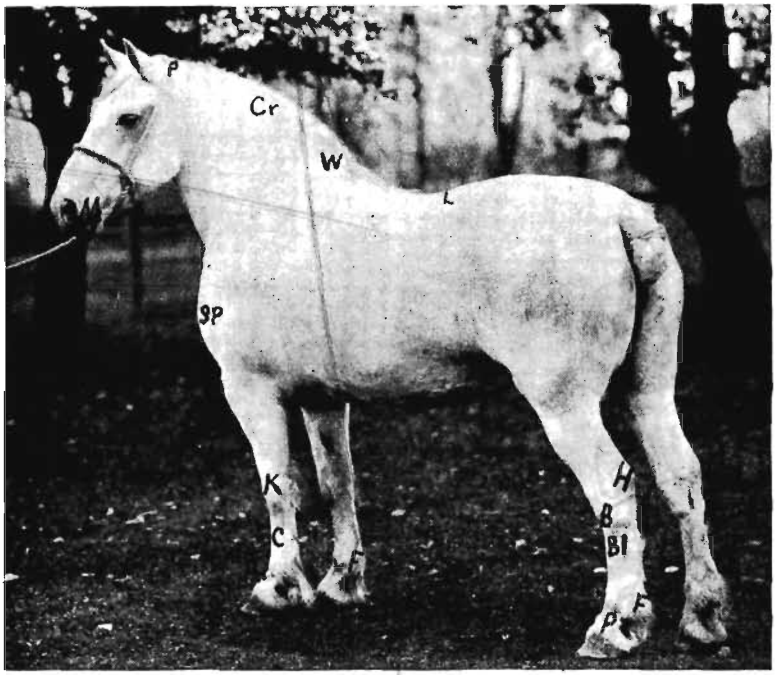


Fig. 269. Percheron brood mare marked to explain points: P, poll; Cr, crest; W, withers; L, loin; H, hock; B, locating bone-spavin; BI, locating bag-spavin; P, pastern; F, fetlock; C, cannon; K, knee; SP, shoulder point; M, muzzle. (Photo. from Percheron Society.)

of care and management, regarding feeding, grooming, prevention of disease, soreness and lameness; how are the harnesses cared for? Examine horses for different diseases and learn to treat them.

7. **Exercises.**—Examine sound and unsound horses for defects, blemishes, bad habits, and unsoundness of any kind. Compare animals that are sound with those that are unsound in different particulars. Practise judging horses of light and heavy types. (Fig. 269.) Collect specimens of diseased and sound hoofs from veterinarians or from animals that have died in the region. Collect leg bones also. Jaws showing teeth from horses of different ages may be collected for future study. Test a sample of mare's milk for butter fat with a Babcock tester. Determine from this how you would modify cow's milk to suit an orphan colt being raised by hand. Practise braiding manes and tails, grooming horses, bandaging wounds, stitching cuts, disinfecting sores, cleansing and washing horse collars, clipping animals, blanketing, and trimming hoofs.

8. **Horse and Mule Projects.**—First study the local situation and markets to be sure that production projects of this kind would probably be as profitable as *other lines of animal industry*. *Outline* the steps, beginning with the selection of breed, and continue until colts are ready for sale The project outline may cover a period of one or more years.

Questions and Investigations

1. Give points for and against horse breeding.
2. What types would suit your region best? Why?
3. Compare Clydesdales and Percherons.
4. Compare Shires and Belgians with Percherons.
5. What are the chief uses for light horses?
6. Compare Thoroughbreds, Morgans, and American saddle horses.
7. Compare Thoroughbreds and Standardbreds.
8. What breeds are most popular?
9. Compare mules with horses.
10. Give directions *for examining for unsoundness.*
11. Give suggestions on the care and management of horses.
12. Give feeding directions suited to your locality.

Farm Mechanics.—Make and repair water troughs; feed troughs; mangers; stalls; doors; floors; gates; colt creep. Repair parts of harness by riveting process. Repair barn roof. Paint barn.

Calculations.—1. Two farmers with four horses each averaging 1,200 lb. fed the two following daily rations for 6 months:

Farmer A	Farmer B
Timothy hay, 8 lb.	Timothy hay, 8 lb.
Corn meal, 6 lb.	Corn meal, 6 lb.
Alfalfa meal, 7½ lb.	Wheat bran, 6 lb.
	Linseed meal, 1½ lb.

Ton prices were: timothy hay, $20; corn meal, $21; alfalfa meal, $20; wheat bran, $19; linseed meal, $30. Calculate the amount of feed of each kind per horse for 6 months. Then find the total cost of same.

2. Which farmer fed the more economical ration? What per cent did he save over his neighbor?

3. Make up a local ration for horses for winter and for summer. At local prices find the cost per month of feeding each ration.

4. If four horses are idle 8 months of each year and the ration is that of Farmer A, problem 1, what must be the feed charge for each work month of each horse?

5. By using four brood mares for horse power on his farm a young man raised four colts each year. Breeding service is $10 each and extra feed cost is $18 each. What is his extra net income from this plan if he sells the colts at an average of $50 each?

SHEEP ENTERPRISE

Analysis into Jobs.—The following teaching units include the main operations in the pursuit of sheep enterprises. References are to pages in *New Agriculture*, Davis' *Farm Projects and Problems*, and to numbers of available *U. S. Farmers' Bulletins*. See also Coffey's *Productive Sheep Husbandry*.

1. **Deciding possibilities of sheep enterprise,** p. 399; *Farm Projects*, 445; *Bulletins*, 576, 840, 920, 1172, 1199, 1546. *Local inquiry.*—(*a*) Study the growing in your region with reference to enemies, costs and profits. (*b*) Get opinions of sheep men regarding these. (*c*) Find prices for wool, lambs and breeding stock for several years.
2. **Choosing the type and breed of sheep,** pp. 399–404; *Farm Projects*, 447–451; *Bulletins*, 576, 840, 920, 1199, 1203, 1632. *Local inquiry.*—(*a*) What types or breeds are most popular locally? (*b*) Compare the breed with the purposes or aims in view.
3. **Selecting and procuring breeding stock,** pp. 402, 404; *Farm Projects*, 447–452; *Bulletins*, 576, 840, 920, 1199, 1203. *Local inquiry.*—(*a*) What prices are paid for good breeding stock? (*b*) Where can good stock be secured? (*c*) Let the best breeders tell you what main points are to be considered in choosing good ewes and rams. (*d*) Ask them as to the importance of trying to select ewes that will produce twins.
4. **Planning barns, shelters and equipment,** pp. 404, 405; *Farm Projects*, 446, 451, 452; *Bulletins*, 810, 840. *Local inquiry.*—(*a*) Visit farms to study shelters and equipment for sheep. (*b*) Compare them as to economy of construction. (*c*) Choose the form of barn or shed which you prefer and could afford to build. (*d*) Calculate the cost of this. (*e*) Make a list of other equipment and find cost of each item.
5. **Planning rotations and pastures,** p. 405; *Farm Projects*, 446, 452; *Bulletins*, 578, 724, 810, 840, 1179, 1181, 1229. *Local inquiry.*—(*a*) What forage or grain crops are grown on sheep farms of your region? (*b*) Write out rotations followed by the best farmers. (*c*) What crops are grown in temporary sheep pastures? (*d*) How many pasture fields are used for the farm flock? (*e*) Ask sheep men as to the danger of worms where permanent pastures are used.
6. **Feeding the flock,** pp. 404–406; *Farm Projects*, 452, 454; *Bulletins*, 578, 724, 810, 840, 1179, 1229. *Local inquiry.*—(*a*) What feeds are purchased by sheep farmers? (*b*) Study their rations for breeding ewes; for fattening lambs; for others.
7. **Managing the flock,** pp. 405–407; *Farm Projects*, 452–455; *Bulletins*, 798, 840, 1134. *Local inquiry.*—(*a*) How many of the local farmers practice docking and castrating of young lambs for market. (*b*) Get their opinions of these practices. (*c*) Describe a good lamb creep made by a local farmer. (*d*) Into what groups are sheep flocks sorted during winter by good herdsmen?
8. **Managing at lambing time,** p. 406; *Farm Projects*, 452, 453; *Bulletin*, 840. *Local inquiry.*—(*a*) Get one or two good herdsmen to describe the care they give their flock at lambing time. (*b*) Find the number of lambs born and the number raised on each sheep farm. (*c*) Find the per cent for each case. (*d*) Ask how ewes are made to mother their own lambs or strange lambs.

9. **Controlling diseases and enemies,** p. 405; *Farm Projects,* 455, 456; *Bulletins,* 713, 798, 840, 988, 1018, 1054, 1155, 1268, 1330, 1593. *Local inquiry.*—(*a*) How many local sheep men treat lambs and ewes for worms? (*b*) How do they meet the sheep-killing dog problem? (*c*) How do they prevent foot troubles.
10. **Keeping sheep records,** pp. 18, 19; *Farm Projects,* 32–35, 77, 78; *Bulletins,* 511, 572, 782, 840, 1182. *Local inquiry.*—(*a*) Draw a form for a sheep feed record; for a lambing record; for a labor record including hired labor, horse labor and self labor. (*b*) Ask several farmers to keep or estimate items to fill such forms. (*c*) Make a form for keeping sales records of wool, breeding stock, lambs and mutton sheep. Summarize records filled by one or more farms.
11. **Improving the breeding stock,** p. 404; *Farm Projects,* 451; *Bulletins,* 840, 1134, 1199. *Local inquiry.*—(*a*) How many farmers are trying to improve their grade stock by use of pure-bred males? (*b*) Ask them how they improve their pure-bred flock. (*c*) Find what farmers have purchased improved breeding stock, and who have carefully culled the breeding stock recently.
12. **Shearing and caring for fleeces,** pp. 407, 408; *Bulletin,* 840. *Local inquiry.*—(*a*) Describe good methods of shearing which you can find. (*b*) Compare these with poor methods. (*c*) Get farmers to describe the tying of fleeces properly. (*d*) Into what kinds of bags are fleeces packed for market—give sizes and weights.
13. **Producing and selling early lambs,** p. 412; *Farm Projects,* 457, 458; *Bulletins,* 576, 840, 1134, 1181. *Local inquiry.*—(*a*) Ask what special management is required for the production of early spring lambs. (*b*) On what date have farmers sold their earliest lambs in recent years? (*c*) Compare prices received earlier and later. (*d*) Compare coöperative selling with individual selling of early lambs; which is most common locally?
14. **Showing and selling breeding stock,** pp. 407–408; *Farm Projects,* 458; *Bulletin,* 840. *Local inquiry.*—(*a*) Watch or help local farmers prepare sheep for show or for auction sales. (*b*) Help them prepare sale catalogs or study sale catalogs. (*c*) Ask sheep men to compare private selling with auction sales. (*d*) Obtain their opinions as to showing at fairs.
15. **Marketing sheep and wool,** pp. 407–408; *Farm Projects,* 458–460; *Bulletins,* 840, 1144, 1172, 1502. *Local inquiry.*—(*a*) What growers slaughter mutton sheep for home use or for market? (*b*) Ask them to describe the sorting and loading of lambs and sheep for shipment. (*c*) Ask them to describe the working of a wool pool, and compare it with individual selling of wool.

CHAPTER XXV

SHEEP ENTERPRISE

SHEEP are usually raised profitably in regions where grazing land is not too valuable and where sheep-killing dogs (Fig. 270) are controlled, either by public sentiment against them or by laws which provide for payment of damage done to flocks by such dogs.

Projects in sheep husbandry may start in several ways: (1) With bred ewes. (2) With weanling lambs. (3) With ewes and

FIG. 270.—Sheep killed by dogs. Part of flock of 192 head in Calhoun County, Michigan, that were killed in one night by the attack of two dogs. Few of the sheep were bitten or maimed: they were simply run to death. (Breeders' Gazette.)

lambs at side. (4) With a bunch of lambs or wethers to run a feeding and marketing project. The scope and time of the first may be made so large as to cover each of the other projects. The lambs in project four may be chosen from lambs raised in the other projects.

The two main purposes for the raising of sheep are the production of wool and the production of mutton. A number of breeds are now in use for these purposes.

Two Types.—Sheep which are best for mutton are blocky in form and have a conformation corresponding to the beef type in cattle. A type in extreme contrast with this is lean and angular similar to the dairy type of cattle. This type is chiefly used for wool production. The different breeds of sheep, however, are

thrown into three groups: (1) Fine- or short-wooled sheep, grown chiefly for wool; (2) medium-wooled sheep, grown for both wool and mutton; (3) the coarse- or long-wooled sheep, also valued for wool and mutton.

Fine-wooled Sheep.—This group is almost synonymous with the Merino group. The wool is fine in quality and the fleeces heavier, in proportion to the size of the animals, than in other breeds. The wool is supplied with an abundance of yolk which is an oily secretion protecting the wool. This accumulates dust and gives the sheep a dirty appearance. Merinos are all small in size and angular in build. The bucks and aged animals are used for mutton of low quality.

Merinos used in America are of three distinct breeds (Fig.

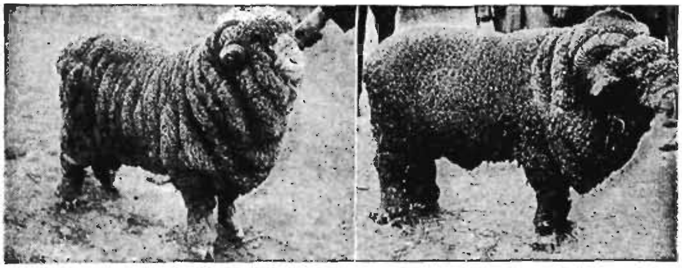


FIG. 271.—Left, American Merino ram showing wrinkles all over except on the back. Right, Rambouilette or French Merino, showing wrinkles only about the neck and shoulders.

271): (1) American Merino; (2) Rambouillet or French Merino: (3) Delaine or Spanish Merino. The females are all hornless and the males have spiral horns. The fine wool covers the body and legs down to the feet but the nose and ears are usually free from wool. The American Merino is the smallest and has deep wrinkles or folds which may be all over the body except on the back. The Delaine is less wrinkled and somewhat larger. The Rambouillet is much the largest of the group and has no wrinkles except sometimes on the neck and breast.

The Merinos are the best of all breeds for grazing on the western plains in large flocks. They are extremely hardy and require little individual attention. Rambouillet sheep are more used in small flocks of the Middle West than other types of Merinos.

Medium-wooled Sheep.—Breeds belonging to this type are much more popular than those of either of the other types because of their general-purpose character. Their lambs mature sooner than those of the larger breeds, or long-wooled sheep. If named in order of popularity these breeds would be about as follows:

Shropshire, Southdown, Hampshire, Oxford, Cheviot, and Dorset. They have brown or black faces, ears, and legs except the Dorset and the Cheviot which have white markings. They are all hornless in both the males and females except the Dorsets and occasionally

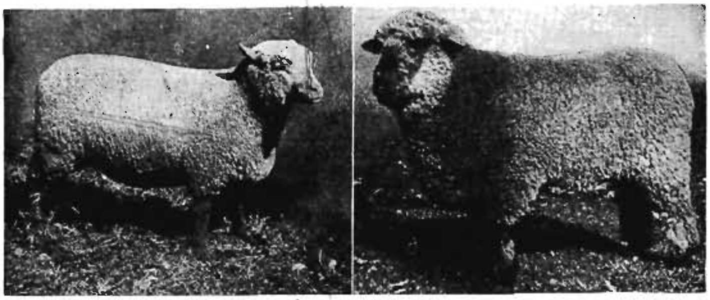


FIG. 272.—Left, Southdown ewe, the smallest breed of the medium-wooled type. Right, Oxford ram, having the longest wool of the medium-wooled type.

the Cheviot males. They all have wool on the faces except the Cheviots which are wooled only to the ears.

Twin lambs are very common among the Shropshire, Southdowns, and Cheviots, which allows them to increase in numbers

FIG. 273.—Typical Shropshire ewes, the most popular breed of sheep. (Coffey's Productive Sheep Husbandry.)

more rapidly than other breeds; but Dorsets may be bred twice a year if desired.

The Southdown sheep (Fig. 272) are inferior in size to other breeds of the medium-wooled group. In type they are well suited for mutton production. The quality of flesh is considered by many as the best of all sheep.

Shropshire sheep (Fig. 273) are larger than Southdowns and among the heaviest of the medium-wooled breeds. They are extensively grown for mutton. In general outline they are more rangy and less compact than the Southdowns. The wool is longer. They

mature early and fatten quickly. Twins are more common in this breed than in others.

Hampshire sheep are larger and coarser and longer in body and the legs are longer than the Southdowns. The wool is of about the same length and fineness. The ears are large and drooping. The faces of rams often show the Roman nose. The legs, faces and ears are almost black.

Oxfords or Oxforddowns are also much larger and coarser than the Southdowns being much higher and more rangy. The wool is coarser and longer than the other breeds of this mutton group. The face and legs are very dark.

Cheviots are quickly distinguished from other breeds of the medium-wool group even by the novice, as the faces and legs are

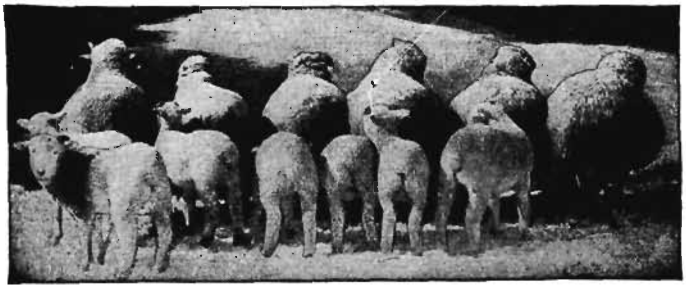


FIG. 274.—Dorset ewes and their winter lambs. This breed is used for early or "hot house" lambs as they breed twice a year.

white and free from wool. The sheep are very hardy and active. The wool is long and soft and highly valued in the markets.

Dorsets or Horned Dorsets (Fig. 274) are a little larger and the bodies longer and the legs longer than in Southdowns. The fleece is slightly longer and coarser than that of Southdowns. The breed is readily distinguished by the horns found in both sexes and by the white legs and faces. Dorsets are considered the most prolific of all sheep, breeding twice annually if desired. They are much used in the production of winter lambs for early market, called the *hot-house lamb* industry.

Coarse-wooled Breeds.—Breeds of the coarse- or long-wooled types are more highly valued for their fleeces than for their carcasses. The chief breeds are the Cotswold, Leicester, and Lincoln.

Cotswold sheep (Fig. 275) are the most popular of the long-wooled breeds in America. The males attain a weight of 250 pounds or more and the breed is considered one of the largest. The lambs are much used for their flesh. These long-legged, large

sheep have no horns; and their white faces have long wool hanging over their eyes. The wool often attains a length of twelve inches and the fleeces will average ten pounds.

Leicester sheep are of much the same type as the Cotswolds,

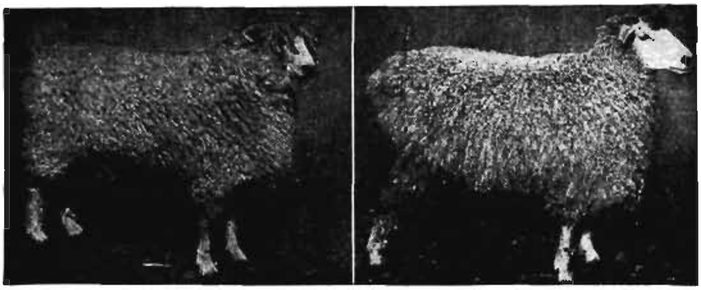


FIG. 275.—Left, Cotswold ewe, one of the largest of the coarse-wooled breeds. Right, Lincoln ewe of the coarse-wooled type, the largest of all breeds.

but the frame is not so large. They are hornless and the heads and legs are white and free from wool.

Lincoln sheep (Fig. 275) exceed the Cotswolds in size, the males sometimes weighing 100 pounds more. They are also horn-

FIG. 276.—Angora goat pair showing characteristic wool. (U. S. D. A.)

less and have white faces, but should have a little wool on the head. The fleece hangs in curly locks and is longer than in any other breed. The average annual fleece is about fifteen pounds.

Goats are closely allied to sheep in farming practices, and are often used in pasturing cut-over timber lands. Angora goats (Fig. 276) are noted for their long white fleeces, sold in the markets as mohair. Milk goats produce milk of special value for certain types

of disease. They will average about one quart of milk per day and are economical feeders. Several breeds of milk goats are used in the United States and other countries.

Choosing Sheep for Breeding Purposes.—From the size of pastures available one may decide the number and general type of sheep to keep. If a small flock is desired a beginner should usually choose a breed of the medium-wool type. Next decide as to the market demands. If early lambs will be most profitable pure-bred Dorsets or grade Dorsets should be chosen. In the hot-house lamb industry sheep breeders often cross Dorset rams on Southdown or Merino ewes. The grade ewe lambs thus produced are then used for winter lamb production.

Always select ewes with wide, strong backs and conformation to suit the breed. Use a score card for the type or breed of sheep

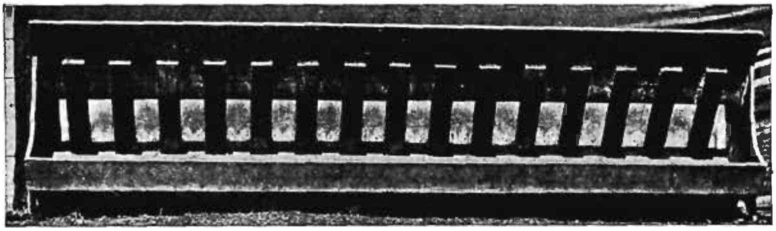


FIG. 277.—Feed rack with slats four inches apart for hay, trough for grain below. Suitable for wall rack or partition. (Coffey's Productive Sheep Husbandry.)

to be selected. In judging sheep it is necessary to "feel them out" as the fleece will deceive the eye. In selecting a flock be sure that the animals are uniform in type, breed, weight, and quality.

Feeding Sheep.—Experience seems to be the best teacher in the care and feeding of sheep. The novice is slow to detect troubles while the experienced feeder may save his animals by foreseeing their difficulties. (Fig. 277.) Internal parasites give much trouble in flocks of sheep. This causes the animals to be unthrifty and many will die. At any time when these parasites are suspected sheep should be drenched with copper sulfate solution or other remedies. (See references.) Feeding will be much more successful if parasites are removed. Keep the bunch of sheep sheltered from rain or snow and keep the ground dry under their sheds. (Fig. 278.) They should not be housed closely. Keep them free from excitement and give them nutritious feed.

For quantity of feed consult books on feeding and learn the feeding standards which conform most closely to the age and size of the sheep in the flock.

When sheep are on pastures they should be kept free from stomach worms. These pests are most serious in warm climates. Rotate pastures often, but also drench: dissolve 4 ounces copper sulfate in 3 gallons water, and use 3 to 4 ounces for large sheep.

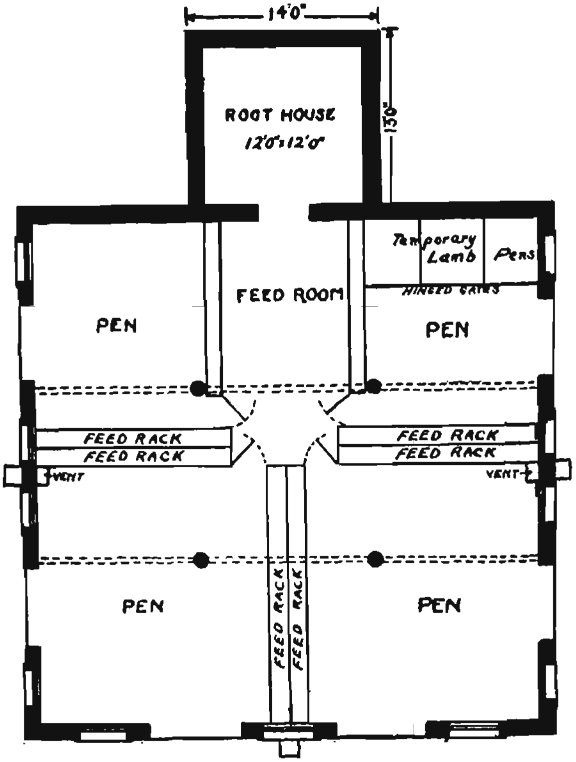


FIG. 278.—Plan of sheep barn on lower floor of side-hill barn, planned for sheep. Upper side is north. Size 40 x 40 feet. (Pennsylvania Station after Canada Bulletin.)

Try to avoid bloat when first turned on succulent pastures. A good plan is to pasture only a few hours each day at first and avoid beginning when the grass is wet with dew or rain. Have shade in the pastures and a good supply of fresh running water. Breeding ewes, on good pasture, seldom need other feed. When pastures are dry or otherwise scanty supply ground grains or whole oats in troughs once each day.

As the winter season approaches, sort the flock before putting them into winter lots. This is specially important when the num-

bers are large. One lot may include the wether lambs, another ewe lambs and another the breeding ewes.

In the winter, supply succulent feeds of some kinds if possible. This may consist of silage or root crops. The grain ration may well be made up of wheat bran and middlings, oats and linseed meal. A good supply of grain is important for the ewes that are to lamb in early spring. The best hays for wintering sheep are clover and alfalfa but others are often used. Be sure that the flock is given gentle exercise daily during the winter. This may be accomplished by the herdsman in various ways without difficulty.

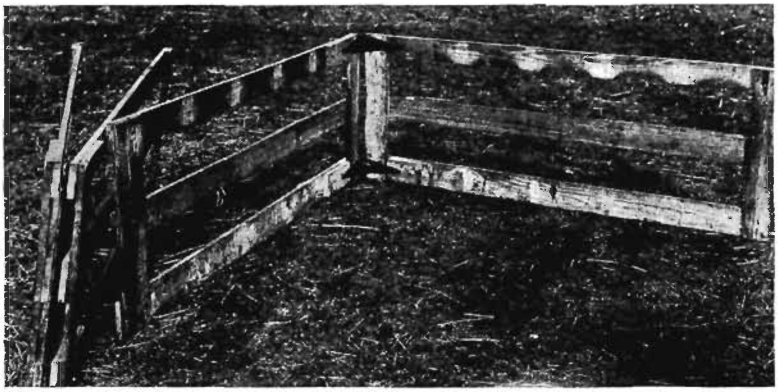


FIG. 279.—Hinged panels may be hooked to walls and to each other to form temporary lambing pens for individual ewes. (Pennsylvania Station.)

Examine the feet of sheep frequently. Trim the toes when they grow too long and watch for foot rot in any form. Bed the quarters well and do not allow damp manure to accumulate. Avoid draughts of cold air in the winter sheep quarters.

Lambing Time.—A careful attendant should always be present at lambing time. Because of this the lambs should all come at about the same season. This can be planned rather definitely as the gestation period is five months. Supply plenty of clean, dry bedding in advance. Separate each ewe when about to lamb from the others by using small folding panels (Fig. 279) large enough to pen her comfortably in a corner of the fold, or she may be moved to a warmer place for the night. Keep the ewe and her lamb together until she nurses it and becomes acquainted with it enough to always own it. Many ewes disown their lambs through mistakes, or otherwise, when they are running with the flock. When twin lambs come see if their mother is able to supply milk for both.

Perhaps one can be given to a ewe that has plenty of milk but has lost her lamb. She may be deceived into owning the strange lamb by covering it with the fleece of her dead lamb, or by smearing peppermint or other odorous material on her nose and on the lamb's rump. Chilled lambs should be artificially warmed by a stove at the house or by the use of hot-water bottles. Be sure that each lamb is first supplied with colostrum from the ewe's udder or that a dose of purgative be used as a substitute.

Feeding Lambs.—As soon as the lambs are able to eat mill feeds, construct a lamb-creep in one end of the fold. Here supply them with a trough containing such ground feeds as are supplied

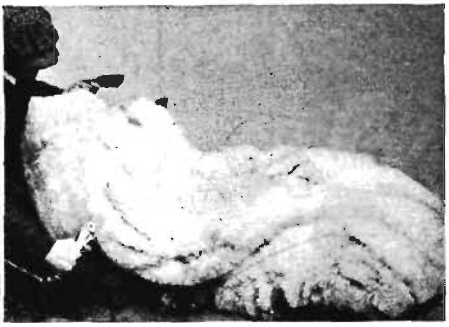


FIG. 280.—Shearing sheep with a machine, beginning at the throat. (Pennsylvania Station.)
FIG. 281.—The fleece should be kept intact and away from the sheep and shears. (Pennsylvania Station.)

to their mothers. Let them have as much of this as they will clean up. This is particularly important for lambs that are to be used for early market and for those that are to be grown for breeding purposes. After the flock is again turned on good pasturage the lamb-creep is less important.

Docking and Castrating.—Winter and spring lambs should have their tails docked as soon as the weather is mild. This is easily done by placing a block of wood under the tail and cutting the tail with a chisel and hammer. Other methods are practised. Apply a little antiseptic before letting the lamb go.

Any male lambs not to be retained for breeding purposes should be castrated at about the same time as docking. The operation is then less severe than later and no losses should occur.

Selling Wool.—The production of good, clean wool properly tied in neat fleeces aids greatly in selling wool at proper prices. (Figs. 280-284.) Wool growers have been very successful in pooling their interests when marketing wool. Such coöperative mar-

keting is far better than selling individually to local buyers. County agricultural agents should be asked to set a definite time

FIG. 282.—The shearing completed, and the sheep ready to be dipped or turned to pasture. (Pennsylvania Station.)

and place for delivery of wool to be sold at auction or private sales. The grades and weights of each man's product should be deter-

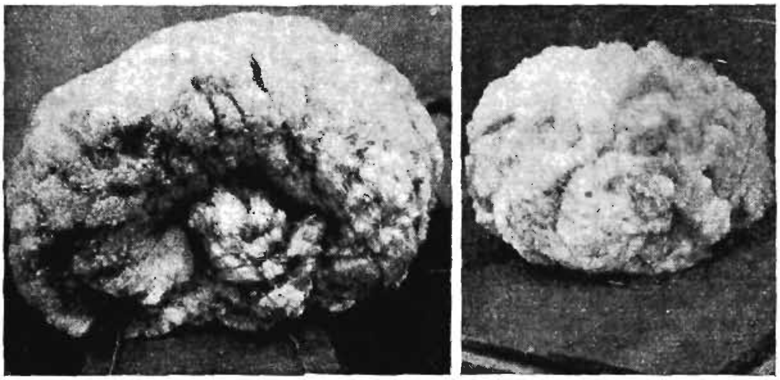


FIG. 283.—A fleece with the edges turned in, tags removed and rolled, ready for tying. (Pennsylvania Station.)

FIG. 284.—Fleece pressed together with wool box, seen in figure, and tied with two or three strands of glazed twine. It is now ready to pack with other fleeces in wool sacks for storage or for sale. (Pennsylvania Station.)

mined in advance. Buyers who want wool of these grades will thus be induced to make offers for the crop. Many wool growers have gained much through such coöperative selling.

Optional Studies.—In special animal husbandry books or sheep books read the history and geographic origin of each of the breeds of sheep. Study more in regard to sheep diseases and their remedies. Look up the laws of one or more states regarding sheep-killing dogs.

Surveys, Trips, Exercises, Projects, and Problems

1. **A sheep survey** should include such points as the following: Number of ewes; number of lambs; breed or grade of sheep; size and number of pastures; crops in pastures; date of lambing; ratio of number of ewes to lambs raised; disposal of lambs not kept for breeding, for early market, for fall and winter market; prices received; winter feeding quarters; treatment for internal parasites; dipping; age when docked and castrated; trouble with dogs; date of shearing; weights of fleeces; winter feed rations.

2. **Problems.**—(1) Compare the ratios between number of ewes and number of lambs with different breeds and flocks in the region. (2) Tabulate these results and, calling the highest 100 per cent, find the percentage of all flocks. (3) Calculate the percentages of loss from parasites, dogs and other causes.

3. **Charts.**—One chart may show the breeds of sheep classified into three groups with the relative sizes, horns, and color of faces. Another chart may give ten or fifteen points on the care of sheep. Another chart may give a ration for rams and another for fattening sheep. Another may show a pasturing rotation system with the kinds of crops. Another may show the chief enemies of sheep and their remedies. Chart cost items of a short feeding project.

4. **Debates.**—"Sheep raising *vs.* swine production." "Fine-wooled sheep *vs.* medium-wooled sheep." "Pure-bred sheep *vs.* scrubs." Debate the dog law question.

5. **Field Trips.**—Visit farms to study and judge different breeds and different types of sheep. Visit farms where lambs or sheep are being fed for market to study rations and uniformity of bunches, to practise sorting, and to judge market types. Assist farmers in loading when sheep are to be shipped. Visit farms at lambing time to study special problems of that period and to assist. Offer to assist farmers in docking and castrating lambs in the spring and the drenching of sheep for worms and dipping and shearing. Visit butchers, abattoirs and packing plants. Visit wool markets or wool buyers to study grades, weights and prices.

6. **Exercises.**—Each student should practise shearing and packing fleeces. Washing, dipping, drenching, castrating, docking, and trimming the feet may be practised at the school. Killing and butchering is a good school exercise. Draw plans of pastures and show dates for summer rotation to avoid stomach worms. Graph the market prices of different market grades of lambs and sheep for a number of weeks.

7. **Sheep projects** may begin in several ways suggested near the beginning of this chapter. Arrange all steps in project sequence, beginning with the season of the year when your project begins. For additional topics of study refer to special sheep books.

Questions and Investigations

1. Mention two main purposes for growing sheep. What are the three groups?
2. Give the characteristics of fine-wooled sheep.
3. Name the three breeds of fine-wooled sheep and compare them.
4. Name the breeds of the medium-wooled group in order of size.
5. Compare Shropshires and Southdowns

6. Compare medium-wooled breeds in their horns and color of faces and legs.
7. Which have longest wool? Which are best for mutton?
8. Name three coarse-wooled breeds and compare them in weight.
9. Describe the fleeces of these three breeds.
10. Give colors of faces and legs.
11. Discuss Angora goats and milk goats.
12. What breeds of sheep are best for large flocks on poor ranges?
13. What breeds are most popular for small flocks?
14. Give your choice of breeds for this purpose. Why?
15. Give points in the feeding of sheep.
16. Give directions for care at lambing time.
17. Why and how would you feed nursing lambs?
18. Give time and reasons for docking and castrating lambs.
19. What sheep diseases are most serious in your region? Give reasons.
20. Give directions for marketing wool.

Farm Mechanics.—Make shelters: sun shade; feed and hay manger; lamb creep. Make or repair dog-proof fence; barns; shearing floors; shearing devices.

Calculations.—1. A young man with 30 ewes saved 33 lambs dropped in one spring season. His neighbor with 32 ewes saved only 18 lambs because of less care at lambing time. Find the percentage of lambs in each case, counting one lamb to each ewe as 100 per cent.

2. These men sold lambs in early market, weighing an average of 80 lb. At a price of 12¢ per lb. what was received by each farmer in problem 1?

3. With grain feed at $1.10 for each ewe during the period from lambing to selling of lambs, in problems 1 and 2, what is the net profit of each over cost of grain? Then find the net loss of the neighbor due to loss of lambs.

4. Two neighbors, A and B, each raised 42 lambs for early market. A feeds lambs in a lamb creep to force them for earlier market, thus receiving 3¢ per lb. more than does B. At 80 lb. per lamb when sold what is A's net gain from forcing his lambs? Allow 20¢ per lamb for extra feed with creeps.

5. Two farmers, C and D, each raise 28 lambs for early market. C docks and castrates his lambs and treats them for worms, and by so doing receives top market price of 12½¢, and averages 82 lb. each. D receives 10¢ a lb. as his lambs graded as "seconds" and averaged 76 lb. each. Find the receipts of each and C's profit over D.

POULTRY ENTERPRISES

Analysis into Jobs.—The following teaching units include the main operations in the pursuit of poultry enterprises. References are to pages in *New Agriculture*, Davis' *Farm Projects and Problems*, and to numbers of available *U. S. Farmers' Bulletins*. See also Dickinson and Lewis, *Poultry Enterprises*.

1. **Determining the nature of the poultry enterprise,** pp. 411, 415; *Farm Projects*, 461–466; *Bulletins*, 684, 697, 767, 1524, Farm poultry; 1391, 1409, 1506, 1507, 1508. *Local inquiry.*—(*a*) Ask poultry men to compare the different poultry enterprises suggested in the first of this chapter. (*b*) Talk with market men regarding these points. (*c*) Compare prices received for eggs, baby chicks, broilers, breeding stock, and live and dressed poultry. (*d*) Determine for yourself, after making these inquiries, which forms you prefer.

2. **Culling the laying flock,** p. 425; *Farm Projects*, 478, 483, 487; *Bulletins*, 1506, 1507, 1524. *Local inquiry.*—(*a*) Examine many flocks and determine how many need culling. (*b*) Get opinions of poultry keepers concerning the value, time and costs of culling. (*c*) Keep egg records of one or more flocks before and after culling.

3. **Feeding the laying flock,** pp. 421–422; *Farm Projects*, 479–483; *Bulletins*, 697, 767, 1229, 1409, 1508, 1524, 1541. *Local inquiry.*—(*a*) Find what dry mashes or dry mash mixtures are used locally. (*b*) Get opinions of feeders of large and small flocks as to the value of home-mixing of mashes; of scratch feeds. (*c*) Try to classify their opinions according to sizes of flocks. (*d*) Find the practices of feeders regarding time of feeding and amount of scratch feed. (*e*) How many use artificial light? Describe a good plan.

4. **Housing the laying flock,** pp. 420, 421; *Farm Projects*, 480; *Bulletins*, 1409, 1508, 1524, 1554. *Local inquiry.*—(*a*) Compare the different types of poultry houses in your region. (*b*) Calculate the areas and roosting space for flocks of different sizes. (*c*) Find examples of houses that are too expensive; are economical; or are too cheap. (*d*) Study buildings remodelled for poultry. (*e*) Calculate the cost of one of the most economical houses you can find.

5. **Breeding for high production,** p. 425; *Farm Projects*, 476–479, 483; *Bulletins*, 684, 697, 767, 1409, 1508, 1524. *Local inquiry*—(*a*) Ask farmers what they think of starting "Community Standardization" of flocks. (*b*) Get their opinions as to the number of eggs per year, as a minimum, for hens in standard flocks. (*c*) What efforts and plans can you find locally for the improvement of breeding stock and production?

6. **Securing young stock,** pp. 417–420; *Farm Projects*, 469; *Bulletins*, 684, 697, 767, 1409, 1508, 1524, 1538. *Local inquiry.*—(*a*) Find the plans by which baby chicks are secured in your region. (*b*) Compare these in economy. (*c*) Get opinions of poultry men who use different plans.

7. **Brooding chicks and managing the young stock,** pp. 416–417, 418–419; *Farm Projects,* 469, 476; *Bulletins,* 684, 1508, 1524, 1538, 1541, Feeding. *Local inquiry.*—(*a*) Find the different types of chick brooders in your region. (*b*) Ask owners to criticize or defend the type used. (*c*) Compare percentages of chicks raised by different methods. (*d*) Find what roosting plans are provided for young stock from brooders. (*e*) Decide which plan is best for your use.
8. **Controlling diseases and parasites,** pp. 423, 424; *Farm Projects,* 487, 490; *Bulletins,* 801, 1070, 1200, 1652, Diseases. *Local inquiry.*—(*a*) Make a list of the serious diseases in local flocks. (*b*) List the parasites. (*c*) Study local sanitary preventions of diseases and parasites. (*d*) Talk with owners regarding treatment for special troubles.
9. **Keeping poultry records,** pp. 18, 19; *Farm Projects,* 32, 35, 78, 79; *Bulletins,* 511, 572, 782, 1182, 1614, Poul. rec. *Local inquiry.*—(*a*) Draw a form sheet for feeding record; egg record; labor record; sales record. (*b*) Ask poultry keepers to fill these records. (*c*) Calculate the costs of production; the income; the net returns. (*d*) Draw a brooder record sheet and an incubator record sheet.
10. **Preparing for show and exhibiting,** pp. 427, 428; *Farm Project,* 491; *Bulletins,* 1506, 1507. *Local inquiry.*—(*a*) What fraction of the poultry keepers have pure-breds? (*b*) Ask them why they do or do not exhibit at fairs. (*c*) Have them describe how birds are prepared for show. (*d*) Ask those with experience how to show birds properly.
11. **Marketing poultry products,** pp. 428, 429; *Farm Projects,* 491–497; *Bulletins,* 1144, 1377, 1378, 1502, 1551. *Local inquiry.*—(*a*) Make a list of the products sold from your community. (*b*) Find how each product is prepared for market. (*c*) What methods of selling of each of these products can you find? (*d*) Compare good and bad methods.

Coöperative Marketing	A Good Coöperative Manager
Maintains higher standards	Knows market needs
Stimulates better production	Understands marketing details
Interests more producers	Has had experience with markets
Makes producers more confident	Is honest and above reproach
Fosters community spirit	Holds confidence of members
Reduces overhead expense	Studies needs of members
Lowers shipping costs	Takes risks when necessary
Opens better markets	Seeks market outlets actively
Functions for middlemen	Acts quickly and timely
Brings better prices	Uses sound judgment
	Bears criticism cheerfully
	Looks far ahead wisely

CHAPTER XXVI

POULTRY ENTERPRISES

THE importance of undertaking poultry projects is clearly shown by the fact that the supply of poultry products is not nearly meeting the demand. Prices for eggs and poultry are extremely high each winter. Cold-storage plants often exhaust their supply of eggs before the normal supply of fresh eggs is sufficient for the markets. The heavy demand for export products is not sufficiently met.

The term poultry, in the broadest sense, includes not only chickens, but other farm fowls. About 95 per cent of the poultry industry of the United States is made up of chickens and their products, and about 1 or 1½ per cent each for turkeys, ducks and geese. The percentage of pigeons, pheasants and guineas is very small. Chickens are the best egg producers and much of the dressed poultry is produced as an adjunct to egg production.

How to Start.—The beginner may start in the poultry business in one of several different ways: (1) Buy pure-bred eggs to be hatched in a machine. (2) Buy pure-bred eggs and a few hens to hatch them. (3) Buy day-old chicks and make or buy an artificial brooder. (4) Buy a flock of pullets in the fall and a sufficient number of males of the same breed. (5) Buy a flock of hens and males to correspond. (6) Students studying agriculture often take over the home flock and manage it for a year, culling and improving it and the equipment in many ways. The time of year will often help determine the method of starting.

Persons without experience should begin in a small way and not have more than one or two hundred laying hens the first season. There are many details to be worked out at the start, yards and houses to be planned, conveniences to make, and methods of sanitation to be learned. Before undertaking poultry raising as a regular business one should have some practical work at a large poultry plant. He should study a number of such plants and should pursue poultry projects for a year or two.

The Undertaking.—Poultry raising requires only a small amount of land and may be easily run in connection with other farm enterprises. The amount of capital for the first investment

and for conducting the business each year may be rather small but it should be increased as the owner acquires more experience.

The labor involved in poultry raising is very great if plans and conveniences are unsatisfactory, but the labor is very light if plans are good and conveniences are provided. One or two attendants may perform all the labor necessary for several thousand laying hens when conditions are favorable. The daily chores must be systematized. Plans for watering, feeding and cleaning must be easy and the consuming details must be so planned in advance as to require no daily attention. Fix upon definite systems and hold to them. The equipment for sake of economy should not be expensive but should be modern. Poultry plants with very expensive equipment seldom pay well.

Types of Chickens.—Success in poultry raising depends to some extent upon the type of chickens chosen for the flock. There are three utility types in America with several breeds in each type (Fig. 285): (1) The special egg breeds. (2) General-purpose breeds. (3) The meat breeds or "heavy" type. A fourth group includes a number of fancy breeds, such as peculiarly feathered or mottled breeds, bantams, etc.

The egg breeds are of slender build, are active birds, good fliers, heavy egg producers and usually non-sitters. They lay eggs better in the winter under proper conditions than most other breeds. They begin laying earlier in life and produce larger eggs with white shells.

Leghorns are the leading breed of the egg type. White Leghorns are by far the most popular. Brown leghorns come next, then the buffs and the blacks, and silver. Combs may be rose or single. Leghorn hens weigh 4 pounds and the males 5½ pounds.

Minorcas stand second among the egg breeds and produce about the largest eggs of any chickens. Black Minorcas are most popular and there are very few whites and buffs. In many of these colors there are both single and rose combs. The standard weight of Minorca hens is 6½ pounds; males, 8; pullets, 5½; and cockerels, 6½ pounds. They lay a fewer number of eggs per year than Leghorns and mature later. They are considered less hardy but are highly prized by their owners.

Other Egg Breeds.—White-faced Black Spanish have single combs. They are one pound lighter in weight than single-comb Black Minorcas. They are probably grown more for fancy than for utility purposes.

Blue Andalusians are probably less popular than other egg

breeds. They are of about the same weight or a little heavier than Leghorns.

Anconas are mottled black and white. The feathers are chiefly black with white tips, giving the mottled effect. It is difficult to breed them true to color types. They are about equal to Leghorns

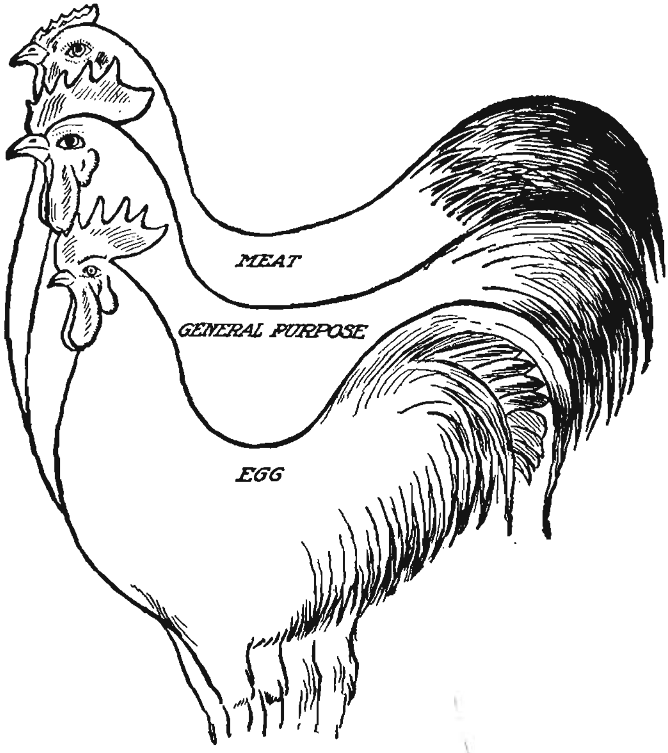


FIG. 285.—*Comparative shapes of the three utility types of poultry.* (Lewis' Productive Poultry Husbandry.)

in egg production. In size and build they greatly resemble the Leghorns.

General-purpose breeds are the most popular on general farms. They all produce brown eggs and lay a good number, particularly during the spring and summer season. They are not as good winter layers as the special egg breeds. The eggs are slightly smaller but are of good size. The birds are more compact in build, quieter in temperament and poorer fliers than the egg breeds. *As a class they make good mothers.* The group includes

Plymouth Rocks, Rhode Islands, Wyandottes, Orpingtons, Dominiques, Javas, Dorkings, and Cornish.

Plymouth Rocks.—Plymouth Rocks are the most popular of all breeds in America, especially the barred variety; but pure-bred birds meeting standard requirements and giving high judging percentages are difficult to obtain because of the tendency to vary from standard type in color. Good show birds are therefore difficult to produce. Standard weights of cocks are 9½ pounds, hens 7½, cockerels 8, pullets 6 pounds. All standard Plymouth Rocks have single combs. Other colors given somewhat in order of popularity are white, buff, silver penciled, partridge, and Columbian.

Rhode Island Reds may have either single combs or rose combs. The eggs are brown or reddish brown. Standard weights of cocks are 8½, hens 6½, cockerels 7½, and pullets 5½ pounds. They are sometimes criticized as being the most persistent sitters of the general-purpose type, but in many flocks this objection is not true. They are more active than others of the group and perhaps lay a little better in the winter. Rhode Island White is a new breed of the same type.

Wyandottes probably stand third in popularity among the general-purpose breeds. They have rose combs and the females range in weight one-half pound lighter than Plymouth Rocks. They have won in some of the egg-laying contests but are also good for broilers and other market meat. White is the most popular color. Other colors somewhat in order of popularity are buff, black, silver penciled, partridge, Columbian, silver-laced and golden-laced.

Orpingtons lay light brown or buff eggs. They are rather heavy: cocks 10, hens 8, cockerels 8½, pullets 7 pounds. They mature rather slowly but lay a good number of eggs in a year. The combs are single on all standard varieties. In order of approximate popularity the colors are buff, white, black, and blue.

Other General-purpose Breeds.—Dominiques somewhat resemble barred Plymouth Rocks in general appearance and color, but are much smaller and have rose combs. Buckeyes are mahogany bay in color and have pea combs. The adults are one-half pound heavier than Rhode Island Reds. Javas are black and mottled: males weigh 9½ pounds, hens 7½ pounds.

The Breeds of Meat Type.—These include several breeds of the Asiatic class. They are very heavy and for that reason are called the meat breeds though they are much less used for meat in America than the general-purpose breeds. They are the only

breeds which have feathered shanks and toes. They are very quiet in temperament, clumsy in action, and because of this make poor mothers. They all lay fewer numbers of eggs than the other breeds. The shells are brown. They seem to be waning in popularity.

Brahmas are the most popular breed of the class. There are both light and dark varieties. The standard weight of the Light Brahma male is 12 and of the hen 9½ pounds. Light Brahmas are sometimes crossed with Rhode Island Reds for the production of capons, which is a growing industry in some sections.

Cochins are a pound lighter than Light Brahmas. They are blockier in build and have shorter legs. The variety colors are buff, white, black, and partridge.

Langshans are nearly as popular as Brahmas. Variety colors are black and white. They are considered better layers than either of the other breeds. Standard weight of the male is 9½, hen 7½ pounds.

What Variety to Use.—For large numbers of eggs, particularly near good egg markets, special poultry raisers usually choose Leghorns or some one of the egg breeds. They produce broilers for city markets quicker than heavier breeds. Heavy breeds are seldom used even for meat as they develop slowly and exercise very little and lack in popular demand. The general-purpose breeds are best for the general farm where both meat and eggs are desired. They are good for broilers, friers and roasters.

In most districts the beginner should strive to accommodate his needs to others of the community. If Barred Plymouth Rocks or White Wyandottes are most in use choose the same breed and variety as this aids greatly in marketing uniform lots of eggs and poultry. This also brings buyers to the region who are seeking pure-bred eggs and breeding stock.

Natural Incubation.—Hatching eggs with a hen depends upon having a hen willing to sit at the time you need her. Hens sometimes leave the nest after they have begun sitting. This is more apt to occur with the light breeds and with the young hens. Heavy hens sometimes crush the eggs or some of them, spoiling the rest. It is often difficult to get hens to sit in a new place where they will not be disturbed by laying hens. Where many chicks are desired in a single season it may be difficult to get a sufficient number of hens to hatch the eggs.

The chief advantages of natural incubation are little investment at the start and the hens are ready to brood them when hatched.

Before setting a hen she should be tested on some artificial eggs or boiled eggs that are marked. If she leaves the nest no harm is done. Select a place where she may be shut away from laying hens and where they cannot disturb her. It is often necessary to have a separate pen for each sitting hen so that she will go back to her own nest after feeding. A barrel on its side with a wire enclosure may serve this purpose. Special small coops may be constructed. These may serve as brooders after incubation. By having a floor in each coop and a door which will close down securely the coop may be proof against rats and other enemies. This floor may be separable from the walls to aid in cleaning.

The sitting hen should be free from vermin. A day before giving her the eggs she should be treated with sodium fluorid powder. The nest itself should be painted a few days in advance with crude petroleum to kill all mites. These materials should never touch the eggs. When a hen is set supply as many eggs as she can conveniently cover. Fifteen is a good average number. It is well to set several hens the same day. This will allow you to test and remove all sterile eggs in seven days. Do the testing at night. Eggs from one hen may be moved to another at that time to maintain the numbers under each. Supply fresh eggs to those that have none. For each sitting hen provide food and water where she can easily get at it each day. She is likely to select her own time for this and will turn the eggs herself. If the nest becomes foul clean it carefully, disturbing the nesting material as little as possible. Always record the date when the eggs are given to the hen and watch for the twentieth and twenty-first days when they should hatch. Avoid disturbing the hen during incubation time, but if necessary remove the baby chicks to a warm place from hens that tend to leave the nest too soon with the first-hatched chicks. Poor hatches are usually due to poor sitters or poor eggs if you have given proper management.

Natural Brooding.—At hatching time, induce the hen and chicks to stay on the nest as long as you can. The chicks do not need feed for the first sixty hours. When they are removed clean up the nest well and treat for vermin. The hen may also be treated with sodium fluorid powder. Provide a good individual coop for each hen where she can protect her brood from enemies and bad weather. (Fig. 286.)

Arrange to keep her in until dew is off the grass each morning. Hens will, if allowed, take their chicks into wet grass and weeds and lose a number of them. Rather close confinement in shelter

or in a very small pen is better at first. Movable cover yards are used with much success for hens that wander too much.

The feed for baby chicks should be the same under natural brooding as in artificial brooding.

Incubators.—There are two main types of incubators besides the mammoth machines used by professionals. They are air-heated machines and water-heated machines. Air-heated machines are more popular as they give no trouble from leaking and corrosion and should last many years. In the past the small machines have usually been heated by kerosene lamps with metal chimneys which prevent danger of explosion and smoking. Recently, electrically heated machines of several makes have come upon the market and

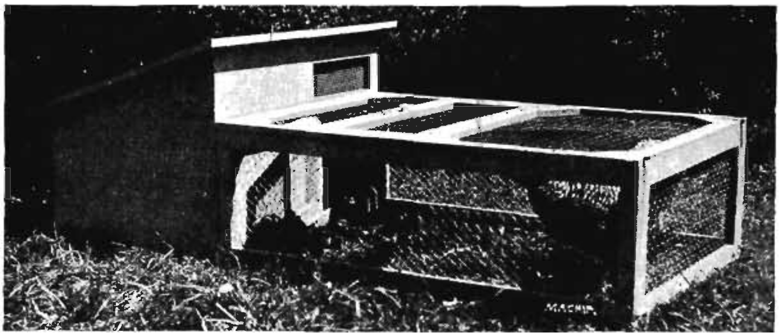


Fig. 286.—Movable coop for hen and chicks. Chicks are protected from their enemies or confined when grass is wet. (Kansas State Agricultural College.)

some of these are suitable for use where electric current is available. The incubator should be supplied with a good thermometer which has been tested by comparing it with another standard theromometer. Set the machine on a firm floor where walking will not shake it. The temperature of the room should be as uniform as possible. Do not place it in a living room where a fire is kept only a part of the time. The room should have good air but be free from drafts. A well-ventilated basement is a good place. (Fig. 287.) The parlor, if not too much occupied, is often used in rural homes.

Start the heat several days in advance and get the regulator adjusted to hold the temperature evenly to 103 degrees F. before the eggs are supplied.

Eggs for Hatching.—Avoid, if possible, the setting of large numbers of eggs which have been shipped by mail or express, or which have been carelessly hauled long distances. The germ in the egg is supported by a suspensory ligament, which is easily

broken by shaking. The eggs should be uniform in size, shape and color.

Avoid those with unusually rough shells or thin shells or with ridges or lumps or peculiar shapes or too large or too small in size. Eggs should not be washed but should be naturally clean.

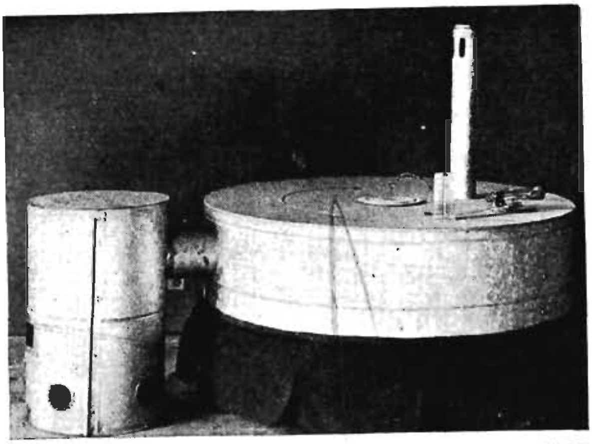
They should be fresh. Never set eggs more than two weeks old. They should be turned daily. The age of an egg may be detected by the size of the air cavity at the large end when candled.

The Brooder House.—A shed or house large enough to accommodate one hundred or more chicks is often a great help during the brooding season. If baby chicks are purchased, or hatched with an incubator, they need a place separate from older birds. A large hover may be suspended from the ceiling to within a few inches of the floor to suit the height of the chicks. Such a hover may be made of composition board with a fringe of cloth. The room may be kept warm with a small stove; or a brooder lamp placed beneath a hover, over a metal square on the floor, may supply the heat in moderate weather. The fumes should be conducted out through the top with a small metal flue.

Fig. 287.—A cheaply constructed incubator cellar, suitable for special poultry farms. The room temperature may be nearly uniform. (Lewis' Productive Poultry Husbandry.)

Purchased hovers (Figs. 288 and 289) and brooders may be no more successful than home-made ones. While expensive, they may supply the beginner with equipment which he much needs. Place this building in a well-drained spot with the open side toward the south. A good windbreak on the north and west is desirable. When the chicks are ready to begin roosting remove the hover and supply roosts in the same room if desired. This may be their home until ready to be culled for market or for breeding purposes.

Running the Incubator.—Place the eggs in the machine, supplying as many as it will hold. Do this early in the day so you will have time to let them acquire the proper temperature before night. The regulator should not need changing at this time. The daily attention to a machine heated with a lamp should be as follows: (1) Turn the eggs daily after the first two days and cool during turning. (2) Trim and fill the lamp once or twice a day, depending on the size. (3) Record the temperature night



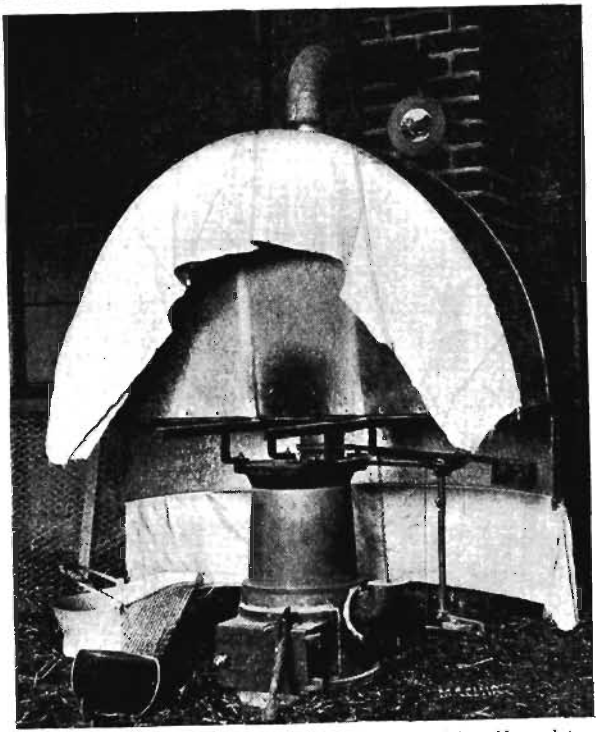


FIG. 288.—(Above) Small indoor brooder with self-regulator, thermometer and fume pipe. Heater is supplied by a brooder lamp in the lamp chamber at left. (Kansas State College.)

(Below) Coal stove brooder, suited for 200 to 500 chicks. (Kansas State College.)

Photo by Cornell University.

FIG. 289.—Students killing and picking poultry. (Lewis' Productive Poultry Husbandry.)

and morning before turning the eggs. (4) The room temperature should be recorded on both a wet-bulb and dry-bulb thermometer.

If the difference of these is more than eight or ten degrees the room is possibly too dry for successful incubation. Put water on the floor or supply it otherwise.

On the seventh day eggs should be tested. (Fig. 290.) Remove clear eggs where no germ can be detected. Write a question mark on any that are doubtful or in which the inner structure seems to be peculiar. Put these to one side in the machine and examine them a few days later.

On the fourteenth day retest all the eggs and see if they are developing properly. When the eggs begin to pip cease turning

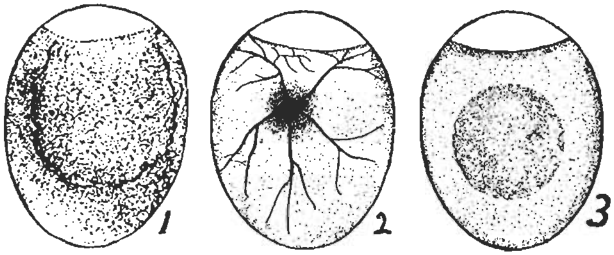


FIG. 290.—Seventh day testing of eggs. 1, dead germ; 2, fertile egg with live germ; 3, infertile egg. (California Station.)

them. Do not open the machine any more than necessary until hatching is over. If the room has been rather dry sprinkle the eggs with warm water.

When the hatching is completed remove shells and unhatched eggs and leave the chicks in the machine, preferably in the brood chamber below the tray until the oldest are forty or fifty hours old.

Now they are ready to go to the brooder. Its temperature should be above 90 degrees, preferably 95 degrees the first night. In moderate weather the night temperature may be lowered to 80 or 85 degrees the second week and still lower later on.

Feeding Baby Chicks.—When a chick is hatched from the egg the yolk of the egg is absorbed and supplies nourishment for the first two days. When the chicks are removed to the brooder give them a drink of buttermilk and a supply of fine gravel, coarse sand or other suitable grit. A little meal may be scattered in this to induce them to eat it more rapidly. Never give feed before grit is supplied.

Good feeds for the first two or three days may be chosen from the following: (1) Rolled oats. (2) Hard-boiled eggs mashed

finely with a fork and mixed with middlings and crumbs of bread. Mix grit with this. (3) A wet mash of buttermilk, bran and middlings. Buttermilk may be supplied as a drink from the very beginning and should be continued for the first two weeks or more. It is a good bowel regulator. Keep dry mash clean in a hopper.

This may be composed of a mixture of middlings and gluten meal (corn hearts) in equal parts. A little corn meal or a little bran may be added. Keep grit before the chicks at all times. Avoid having millet and other hard-seeded grains in the feed. Supply green feed as alfalfa or clover leaves or sprouted oats, beginning the second week.

An elevated wire floor in the brooder is important. Tack ¼-inch mesh woven wire on wooden frames to support chicks an inch or two above the brooder floor. This prevents chicks from eating the droppings. Trays may be used to catch droppings particularly in battery brooders similar to fattening crates (Fig. 297). Supply heat and sand to keep droppings dry. Thoroughly sweep out and remove all dust and droppings frequently.

The Laying House.—Locate the laying house where drainage is good and where the sun can strike it. The open side should be toward the south. For a permanent house the floor and foundation may be of concrete for ease of disinfecting and to keep out rats.

The walls need not be expensive nor very warm but should be closely built to avoid drafts from the north, east and west sides. (Fig. 291.) Open-front houses are becoming more popular in all climates as far north as New England. Some glass is used on the south side in the cold regions. Elsewhere a wide strip on the front is covered with wire netting and white cloth and no glass is used.

Sizes.—A floor space of 14 or 16 feet square makes a good unit for building. Increase the size by multiplying the unit, each additional unit being added on the end as desired. If fenced yards are used they may extend in front and behind each unit. Long laying houses of several units may accommodate any number of birds desired. The shed type of roof is most economical. The height at the back may be about six feet and the front eight feet from the floor.

One unit should accommodate about sixty to seventy-five laying hens, or more when they are not kept shut in too much.

Interior of Each Unit.—Place the dropping board at the back side of the house. Make it level and smooth on top. It should extend clear across the room and be about four or five feet wide.

The roost should be supported on short standards about eight inches above the dropping board. Make them of two by two lumber with beveled corners. Construct them so they may be lifted off or raised toward the roof when the dropping board is to be cleaned. Under the dropping board place a line of nests on a narrow platform about two feet from the ground. Allow room

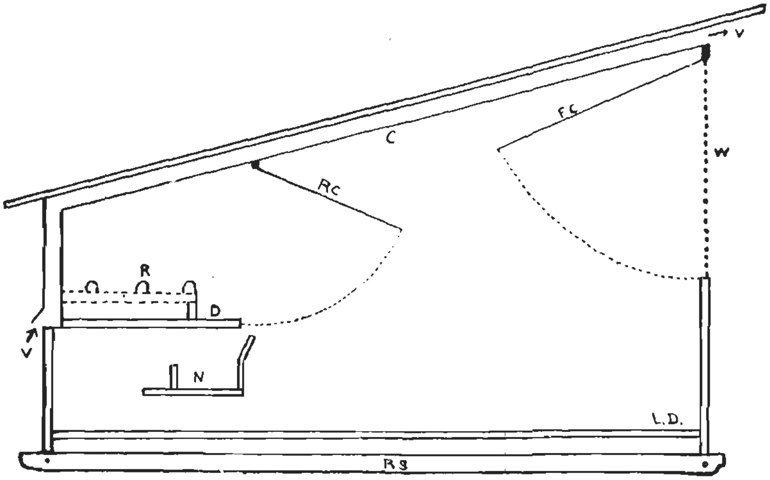


FIG. 291.—Sectional view of shed-roof poultry house, 16 feet from front to rear on runners (RS). A ceiling (C) may provide for a ventilator (V) left open in summer and closed in winter. Nests (N) are beneath the dropping board (D). Roosts (R) should be easily lifted for cleaning. The door (not shown) may be in centre of front, which has poultry wire (W) and muslin curtain (FC) open on bright days. Fowls may be protected on cold nights by roost curtain.

behind the nests on the platform for hens to walk and choose their nests. A black curtain or a wooden door may be suspended in front of the nests from the dropping board to make them darker. Construct nests without bottoms so they can be easily removed and cleaned. On the east or west wall of the room in front of the dropping board hang a dry mash hopper and on the other wall construct a small drinking platform, where a fountain may be kept. The floor should be supplied with plenty of litter and a box of grit, charcoal and minerals may be kept in one corner.

Feeding Laying Hens.—The dry mash system combined with morning and evening scratch feed gives best results in egg production. The dry mash may be mixed at home and if so, is usually much less expensive than ready mixed mashes. The following summer and winter mixtures are suggested:

Summer Dry Mash	*Winter Dry Mash*
1 part wheat bran	2 parts wheat middlings
1 part wheat middlings	1 part gluten or corn hearts
1 part gluten or corn hearts	1 part alfalfa meal
½ per cent salt	½ part of meat meal or milk powder
Grit, if desired	½ per cent salt
	1 per cent cod-liver oil
	4 per cent bone meal

The dry mash should be placed in a self-feeding hopper from which the hens may eat without wasting.

The dry mash may be kept before the fowls at all times or may be closed a part of each day if desired. Its combination is about like that for egg production. If plenty of fresh water is supplied the salt will induce the hens to drink more water. Hens always dislike to eat very much dry mash but will satisfy their appetites and production needs when it is before them constantly. The use of a hopper saves much daily labor. The hens are allowed to get their breakfasts earlier in the morning and to feed late at night.

The scratch feed for laying hens should consist of broken or small grains supplied in a rather deep litter on the floor. If it be too coarse they will not scratch enough to give them the exercise they need. The scratch feed should be given just before roosting time and early in the morning, and never give enough to satisfy their appetites as they must be induced to eat the dry mash.

Experiments have shown that more eggs are secured economically, where electric power is cheap, by turning on electric lights automatically about four o'clock, in the winter season. This induces hens to begin work early and lengthens their working day. This corresponds more closely to the summer day when eggs are naturally abundant.

Cracked corn from which the fine meal has been sifted, may be mixed with wheat screenings, whole or clipped oats and kafir grain. Avoid paying more for ready mixed scratch feed than the market price of the grains found in it.

Winter Succulence for Hens.—To produce eggs in the winter hens must be induced to eat succulent feed and drink more water than normally. Salt in the dry mash, the warming of water and changing the water at least twice a day, will all help. Fresh buttermilk or semi-solid buttermilk, diluted, is one of the best aids for winter egg production. Alfalfa meal in the dry mash cannot entirely take the place of succulence. In warm climates have some

winter clover or grain growing where they can range on it when weather will permit.

In cold climates cabbage leaves and heads, rutabagas, and similar crops may be grown for the purpose. Some extensive feeders supply steamed alfalfa and clover hay daily. Sprouted oats, soaked or grown in flat trays for a week or more, may be supplied daily at the rate of one ounce per hen. This will give excellent results. Seven trays, each large enough to supply the daily ration for the flock, may be kept like drawers in a rack in a warm place. (Fig. 292.) As each tray is emptied it is refilled with soaked oats to be fed a week later. The water used in soaking the oats may contain about one-half per cent of formalin.

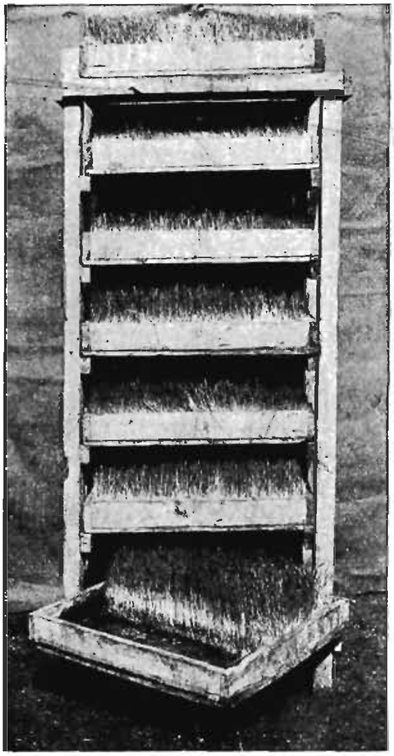


Fig. 292.—Rack for sprouting oats for winter greens; large enough to provide a flock of 500 laying hens with enough daily. (Lewis' Productive Poultry Husbandry.)

Sanitation.—The laying flock as well as the young stock should be given daily care to keep the quarters sanitary. The dropping board in the laying house should be cleaned as often as necessary to keep it perfectly dry. Each time it is cleaned spread over it some sand or dust as an absorbent of moisture and odors. The floor should be cleaned often enough to prevent the serious accumulation of dust and droppings. The frequency of this depends on how closely the birds are housed. It should be most frequent in the winter. Dry litter should be added of a sufficient depth to give the birds plenty of exercise. Straw of small grains, if not too long, is excellent for litter. If the straw be long supply a little at first, and as the birds scratch it to pieces more may be added.

Mites and Lice.—These are most serious in warm weather. Houses and flocks thoroughly freed from them in late fall will

probably not be bothered during the winter season; but in the summer, treatments should be more frequent. Mites live on the birds at night, sucking blood. Most of them are on the roosts, dropping boards and nests during the day. Here they can all be easily killed by smearing on plenty of crude oil, or kerosene in which has been dissolved wagon grease or lard. When the nests are cleaned paint all surfaces profusely with this and cover the roosts and dropping board completely, not missing any spots on the under side or ends. Crevices should be flooded.

Lice on birds are of several kinds. Some are worst on the bodies and others on the heads. Some attacks the feathers more than the skin. All, however, are controlled by about the same methods.

Sodium fluorid in the form of fine powder may be put in a can with holes in the top, like a pepper shaker. As the feathers of the bird are raised with one hand the powder is shaken on the skin. Another plan is to put a little of the powder in a vessel of water, keeping it well stirred while the birds are one by one immersed in it. Do not allow them to take cold.

Another treatment for lice on birds is to spray them with a hand atomizer, using rather light crude petroleum, or kerosene in which lard has been dissolved, or an emulsion of soap and water with either of these.

Sanitation in Yards.—Gapes and germs of bowel troubles and perhaps of roup, canker and other disease are likely to find lodging in the soil of poultry yards. For this reason regular rotations and tillage should be practised. Plow or spade up each yard once a year or perhaps oftener. Apply lime in abundance each time after the plowing. The use of a bare-fallow period for a few weeks will help. Resow the yards with small grains, clovers, alfalfa, rape, turnips and other crops according to the season. Light, sandy soils with good drainage are less likely to foster such troubles.

Roup is a disease similar to a very severe cold. Do not allow the birds to roost in trees or in bad drafts. Roup often causes swelling of the throat, eyes, tongue or other parts. Some forms of it are accompanied by profuse secretions, while other forms are not. Birds affected with any such trouble should be separated from the flock and kept in a quarantine coop for treatment.

Swab the parts with kerosene and apply a little kerosene on the top of the drinking water. When sick birds have been cured they should be fattened and sold. Seldom should such birds be returned to the laying flock. A very small trace of potassium

permanganate in the drinking water, or a little kerosene on top, is not bad for all the laying hens in cold weather.

Points on Culling.—Young stock should be culled first as soon as the males are large enough for broilers, weighing three-fourths to two pounds. Unless you are to have sale for a number of males for breeding purposes, most of them should be sold as broilers. At the same time or a little later remove all undesirable females. Any that have shown disease are less likely to develop into good layers. Remove those that are undersized, have bad conformation or other characteristics, or are crippled. Prices are

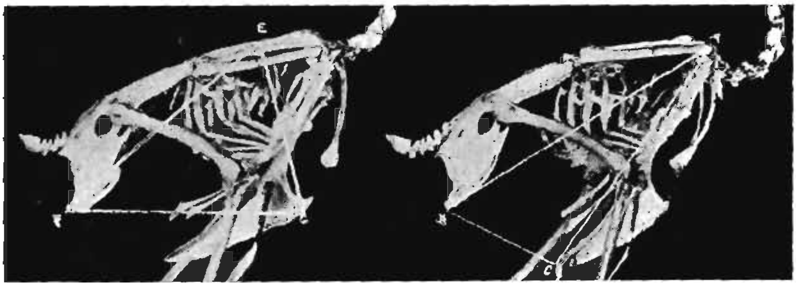


Fig. 293.—Skeleton of non-layer (left) and the high producer (right). When judging body type of *good* hens that are *not* laying emphasis is placed on the size of the triangle, E-F-G. The triangle emphasized in judging hens in *full* production, is A-B-C. When a hen stops laying, the point *C moves toward* B *so that the distance* B-C varies with egg production, while the points E and F remain the same whether the hen is laying or not; hence the value of the points E and F in judging type. (Kansas State Agricultural College.)

better for broilers than for older birds. Feed, care and room will be saved by doing the culling early.

Young stock should be again thoroughly examined and culled just before they are put into winter quarters. Remove the males from the females at this time if it has not been done earlier. Breeders can usually afford to dispose of all of the young males early in the season. All breeding males should be removed as soon as the breeding season is over each spring. Secure new males next season in time for mating. Never keep males with hens producing eggs for market.

Each fall when pullets are selected for the next laying flock the owner should finish culling the old layers. Laying hens should be watched carefully throughout their entire laying life for the purpose of removing the non-producers. These may be detected in a number of ways.

Signs of a Good Layer.—(Figs. 293-295.) (1) Bright, red comb and wattles which are well developed. (2) A wide spread of pelvic or lay bones, measured by the width of three fingers. (3)

A good distance between the end of the breast bone or keel and the pelvic bones. (4) A loss of bright color in pigment in the

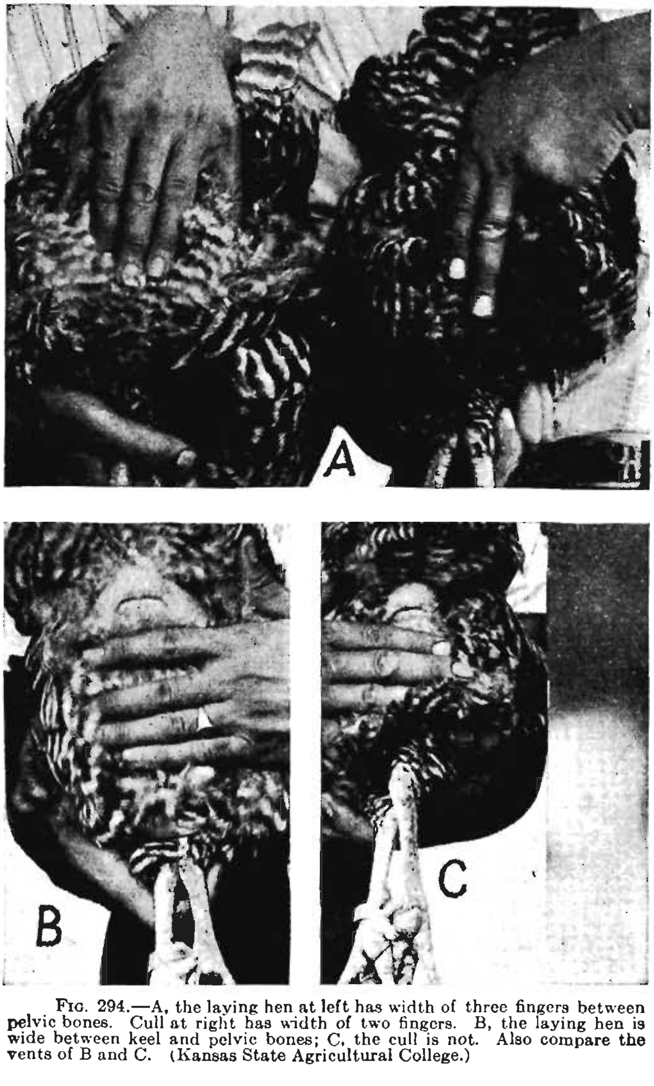
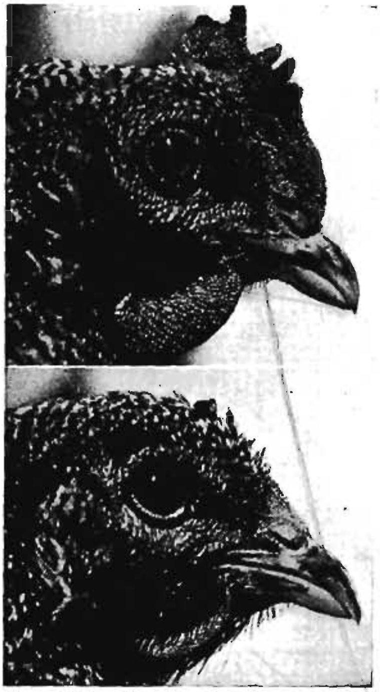


FIG. 294.—A, the laying hen at left has width of three fingers between pelvic bones. Cull at right has width of two fingers. B, the laying hen is wide between keel and pelvic bones; C, the cull is not. Also compare the vents of B and C. (Kansas State Agricultural College.)

shanks, the eyes, the beak and the skin near the vent. (5) Alert action as shown in feeding, going to roost late at night and coming off early in the morning.

You may detect a layer by finding her on the nest. She should be given a leg band for future identification. Trap nesting is often used, particularly for the improvement of small pure-bred flocks and for the pedigreeing of eggs, each egg being marked with the number of the hen laying it.



FIGS. 295, 296.—Head of laying hen (above) showing well-developed comb, wattles, and ear-lobes, the full-eye, and the short, well-curved beak. Below, head of cull with reduced comb, wattles and ear-lobes, prominent eye-ring, sunken eye, and more color in beak. (Kansas Station.)

By the Utah method, hens may be caught and examined early each morning. The egg may be felt by an experienced person, if it is to be laid that day. A record sheet should be used to give each hen proper credit.

Whenever a hen, during the summer or fall, shows signs of non-laying she should be put on the "black list" in another yard and if she does not begin laying soon she should not be kept. Many flocks have short-season layers. They produce few eggs annually. If these are fattened and sold for meat the percentage of eggs from the flock will be greatly increased. Early molters are usually short-season layers and molting can be quickly detected. Remember that all culling should not be done at one time; and never neglected until all of the birds are in the molt.

Old hens should not be kept unless they are known to be good producers. In the most intensive egg-producing flocks the layers are kept for only one or two years of work.

Crate Fattening.—(Fig. 296.) Poultry keepers find it profitable to grade the culled birds and perhaps purchase others from neighbors and feed them intensively for market. Metal coops with dropping trays below the slatted floors are manufactured for this purpose. Home-made trays can be easily devised for easy cleaning and may be less expensive. Fill each crate with a uniform lot

of birds. Feed them a wet mash in a trough hanging along one side of the crate so the birds may feed easily between the bars. A good mash for this purpose is made by mixing several kinds of ground feeds such as middlings, corn meal, gluten, and alfalfa meal and some grit, with semi-solid buttermilk and water. Sour skimmilk may be substituted in dairy regions. The mixture should be of the consistency of thick cream. Supply the birds with all they will clean up well at least twice a day. The feeding period

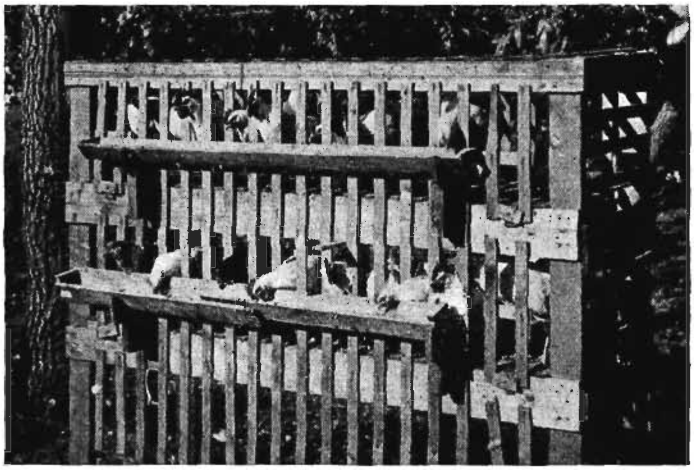


FIG. 297.—Home-made fattening crates showing feeding troughs in use. (North Dakota Station.)

should continue from one to three weeks, depending on market requirements and the flesh of the birds.

Birds so fattened may be sold on the market as milk-fed chickens and will bring the highest prices.

Marketing Eggs.—Eggs are often sold coöperatively by several members forming an egg circle, and shipping eggs together by parcel post, express or freight. In many such cases they ship directly to consumers or dealers who pay them a premium over the market price of farm eggs. A secretary or other officer should be designated, whose duty is to record the numbers of eggs of different grades supplied by each member and to attend to the shipment and sales of eggs, and distribute returns to the members.

This person or some other competent one should carefully candle and grade the eggs. The chief element in grading consists of examining each egg in a dark room before a bright spot of light. This is called candling. Freshness is easily detected. All having

blood rings or worse are discarded. Eggs will usually bring better prices if sorted to uniform sizes and colors in each lot.

Marketing Other Products.—In rural districts poultry keepers should coöperate with each other in making up uniform lots of live poultry for shipment to market. Better shipping rates can be secured for large lots and better prices are secured when they are graded according to sex, age, weight and color. Some producers have successfully coöperated in establishing poultry packing plants where the birds, after being graded and fed, are dressed, cooled and packed before shipment. The profits arising from such a plant are very great and need not require expensive equipment, the *most expensive feature being the cooling facilities.* Large ice refrigerators or ammonia plants may be used. In large centres where cold-storage plants are found space is sometimes rented for cooling of poultry before shipment. Quick cooling by plunging in ice water is sometimes practised in places where cold rooms are not available.

Optional Studies.—Other breeds should be studied, particularly those represented in the community. See U. S. Farmers' Bulletins 806, 898, 1052, 1221, 1251 for a complete list of all breeds of chickens with their varieties and descriptions.

In special poultry books read the historical development of domestic fowls. Look up the history of the breeding of each of the leading breeds of your region. Learn the disqualifying points likely to be found in each of the leading breeds.

Surveys, Trips, Exercises, Projects, and Problems

1. **A poultry survey** should be made to determine methods of managing large flocks of special poultry breeds. The study involved in such a survey will develop many valuable points. Include such topics as these: Number of laying hens; breed; products marketed; number of eggs; number of broilers; number of friers; number of fowls; ratio of housing space to number of birds; methods of incubation and brooding; baby chick rations; laying rations; ready-mixed or home-mixed; ratio of man labor to number of layers; losses from disease; names of diseases; remedies used; ratio of yard space to numbers; frequency of cleaning dropping boards; frequency of cleaning floors; frequency of plowing yards.

2. **Problems.**—(1) Compare the ratios between man labor and numbers of layers on different farms; determine which is most economical and get the percentage which others bear to this. (2) Determine, if possible, the ratio existing between losses from disease and frequency of cleaning houses and yards. (3) Get the percentage of egg production for each farm; average them and explain, if possible, the low averages. (4) Compare the ratios of housing space to number of birds with each other. Find the average of these and compare the closeness of housing of the extremes with those near the average.

3. **Poultry charts** may be made on each of the four subjects of the preceding paragraph. Make a chart of the leading breeds classified as to their types and give the variety colors and combs for each. Make a

chart showing the main points in artificial incubation; another of the feed for baby chicks; another of the feed for laying hens; another of the points in culling layers.

4. **Pictures.**—Collect from poultry journals, bulletins, premium lists and poultry catalogues pictures of the leading breeds. Make a placard for each breed or for each type of chickens.

5. **Poultry Debates.**—"Artificial incubation and brooding *vs.* natural methods." "Single long houses for laying hens *vs.* many small individual houses." "Light breeds *vs.* general-purpose breeds." "Coöperative *vs.* individual marketing." "Culling by individual study of hens *vs.* trap nests."

6. **Field Trips.**—Visit farms for study of methods (a) where pure-bred breeds are kept; (b) where large number of layers are kept; (c) special poultry breeds; (d) where turkeys, ducks or geese are raised. Visit poultry packing plants, and places where you may find crate fattening or coop fattening. Visit markets where eggs are candled and graded. Visit many farms where special poultry products are to be studied, as broilers and capons.

7. **Poultry Projects.**—On the first page of this chapter several ways of beginning poultry projects are suggested. Choose the plan which will best suit your conditions and from that point outline the steps in the project from beginning to end. Indicate the study topics for each step and locate suitable reference material for each topic. The number of birds in the project should not be less than one hundred laying hens, as the labor involved for fewer numbers absorbs all the profit from the enterprise.

8. **Things to Make.**—Make such articles as feed hoppers, trap nests, feeding troughs, feeding crates, exhibition coops, artificial brooders, coops for natural brooding, movable hen houses, brooder houses and other equipment.

9. **Record Keeping.**—Draw suitable records for recording daily conditions in the incubator and room. Also make records and keep accounts of feeding a flock of laying hens and feeding a flock of young stock. Make an egg record and keep it for a given period.

10. **Exercises.**—Practise each of the following: Distinfecting and cleaning fowls and their houses; culling laying flocks; preparing birds for exhibition; judging pure-bred birds by the standard; candling eggs; selecting pullets for future layers; fattening in crates; cleaning and dressing birds for market. (Fig. 297.)

11. **Caponizing** should be practised by all students to learn the methods. Select males weighing about a pound. Keep feed from them for thirty-six hours before operating. Instruments for the purpose may be purchased or made. Read methods in special poultry books. The first operation may be on a dead bird.

Questions and Investigations

1. Give several plans for starting a poultry enterprise.
2. How would you gain experience in poultry keeping if you had none?
3. Give arguments for poultry raising when compared with other farming.
4. Mention three types of chickens. List the egg breeds and compare Leghorns with Minorcas.
5. Which egg breed would you prefer? Why?
6. List the general-purpose breeds of chickens.
7. Compare Plymouth Rocks with Wyandottes and with Rhode Island Reds.
8. Which of the general-purpose breeds would you prefer? Why?
9. Give the colors and weights of Orpingtons.

10. Why are heavy breeds less popular than others?
11. Give reasons for a special brooder house.
12. Give reasons for care of sitting hens. How accomplished?
13. Describe good brooder coops which you have seen.
14. Give directions for selecting eggs for hatching.
15. Discuss types of incubators.
16. Describe a home-made brooder.
17. Give directions for the daily operation of an incubator.
18. Why should eggs be tested on the seventh day? Why later?
19. Give directions for feeding baby chicks. Give temperatures.
20. Describe construction of a single-unit laying house.
21. List the interior equipment.
22. What differences should there be between the winter and the summer dry mashes? Give these.
23. What are the benefits of the dry-mash system of feeding? Why supply scratch feed?
24. How can winter succulence be supplied to hens?
25. What rules should be followed regarding sanitation?
26. Tell how to destroy mites and lice.
27. How may yards be kept sanitary?
28. What directions should be followed in culling young stock?
29. How would you dispose of the culls and males?
30. Enumerate the chief signs of laying hens.
31. Describe crate fattening. Give purposes.
32. What are the benefits of marketing eggs through egg circles? How done?
33. Describe coöperative feeding, dressing, and packing.
34. What are the disqualifying points of your choice laying breeds? General purpose breed? Heavy breed?
35. What are the standard weights of these three breeds?
36. Describe standard coloration of these.

Calculations.—1. A poultryman wishes to hatch and raise enough chicks to produce 200 select pullets for winter layers. He estimates half the chicks will be cockerels and 20 per cent of the pullets will be culled out before winter; of all the chicks hatched 20 per cent may die or be killed as worthless; 40 per cent of the eggs placed in the incubator will be infertile or for other reasons fail to hatch. How many eggs should be placed in the incubator?

2. Double the number of eggs determined in problem 1. Then calculate it backwards and find how many select pullets will be available for winter laying.

3. If the culled pullets and cockerels in problem 1 are sold as broilers when weighing 24 oz., at 22¢ a lb., find the income from them.

BEEKEEPING ENTERPRISE

Analysis into Jobs.—The following jobs or teaching units include the main operations in the pursuit of a beekeeping enterprise. References are to pages in *New Agriculture*, Davis' *Farm Projects and Problems*, and to numbers of available *U. S. Farmers' Bulletins*. See Pellet's *Productive Beekeeping.*

1. **Deciding to keep bees and what form of business,** p. 434; *Farm Projects*, 500–502; *Bulletins*, 447, 653, 961, 1215, 1216, 1222. *Local inquiry.*—(*a*) What favorable or adverse experiences have beekeepers had in your region recently? (*b*) Are beekeepers increasing or decreasing their numbers of colonies? (*c*) Talk with beekeepers concerning the cost of equipment for producing comb honey; for extracting honey.
2. **Choosing the race,** p. 434; *Farm Projects*, 502; *Bulletin*, 447. *Local inquiry.*—(*a*) Get opinions of beekeepers regarding the different races of bees. (*b*) Decide what race you prefer and give reasons.
3. **Selecting and procuring colonies,** p. 434; *Farm Projects*, 503; *Bulletin*, 447. *Local inquiry.*—(*a*) Ask experienced beekeepers how to judge a good colony before buying. (*b*) Find what prices should be paid for good medium and inferior colonies. (*c*) Learn from them how to judge a good hive and what it should cost. (*d*) Ask regarding the best time for buying colonies.
4. **Procuring hives and equipment,** pp. 434–435; *Farm Projects*, 504, 505; *Bulletin*, 447. *Local inquiry.*—(*a*) Show catalogues of hive makers to experienced beekeepers and get their hints regarding equipment. (*b*) Make a list of equipment for comb-honey production; for extracted honey production. (*c*) Calculate the total cost for each list and for the number of hives you plan to keep.
5. **Moving purchased hives,** p. 435; *Farm Projects*, 504; *Bulletin*, 961. *Local inquiry.*—(*a*) Talk with beekeepers and find the plan of each for moving purchased hives of bees. (*b*) Compare these and decide on the best plan. (*c*) Find how to prevent losses of workers when bees are moved. (*d*) What losses have thus occurred locally?
6. **Locating the apiary,** p. 435; *Farm Projects*, 505; *Bulletin*, 447. *Local inquiry.*—(*a*) Study the apiary locations of your region. (*b*) Compare them and decide which are most favorable. (*c*) Talk with owners regarding your proposed location or changes which they propose to make.
7. **Providing bee pastures,** pp. 437–438; *Farm Projects*, 501–502; *Bulletins*, 1215, 1216, 1222. *Local inquiry.*—(*a*) Make a list of the best honey plants of your region and ask beekeepers to compare them. (*b*) What crops should be sown for bees locally? (*c*) Compare the honeys produced from different types of pasture. (*d*) Ask orchardists regarding the value of bees near the orchards.
8. **Managing the colony,** pp. 438–439, 440–441; *Farm Projects*, 507–509; *Bulletins*, 447, 961, 1012, 1014. *Local inquiry.*—(*a*) Ask good beekeepers how to divide colonies. (*b*) Ask these or others how to re-queen colonies. (*c*) Get their opinions regarding the advisability and methods of feeding in early spring. (*d*) Ask them how they rear queens. (*e*) Get local plans for uniting two colonies.

9. **Swarming and controlling swarming,** p. 440; *Farm Projects,* 508–509; *Bulletin* 1198. *Local inquiry.*—(*a*) Find different practices for hiving swarms. (*b*) Get several owners to describe their best method of swarm control.
10. **Controlling diseases and enemies.** *Farm Projects,* 509–511; *Bulletin* 975, Foul-brood. *Local inquiry.*—(*a*) List the diseases and enemies reported by owners. (*b*) Get them to explain how diseases are introduced. (*c*) Find the best methods of control practiced in your region. (*d*) Ask owners regarding the duties and benefits of bee inspectors.
11. **Extracting and preparing honey for market,** p. 441; *Farm Projects,* 511–512; *Bulletin,* 1039. *Local inquiry.*—(*a*) Visit places where extractors are used and learn different methods. (*b*) Compare the containers used for extracted honey, and get opinions regarding these. (*c*) Get honey producers and honest dealers to compare chunk honey and section comb honey for market.
12. **Selling products,** p. 441; *Farm Projects.* 512–513; *Bulletins,* 653, 1039. *Local inquiry.*—(*a*) Ask beekeepers to compare coöperative selling with individual selling of bee products. (*b*) Ask them regarding the value of special labels and brands. (*c*) Get their opinions regarding the best forms of honey to sell. (*d*) Obtain market prices for each type of honey and of wax. (*e*) Get owners to discuss seasons for marketing bee products. (*f*) Get their reactions regarding honey adulteration.

A Good Coöperative Member
Grades and packs products well
Tries to produce the best products
Discards culls and low grades
Thinks of market effects
Reports true farm conditions
Strives to help association
Knows methods, policies and problems
Trusts fellows and manager
Keeps down all criticism
Makes helpful suggestions
Reports efforts to break association
Ignores outside bidding

CHAPTER XXVII

BEEKEEPING ENTERPRISE

Beekeeping may be undertaken as a main enterprise or as a side line in connection with general farming or other special farming. Like poultry raising, it requires little capital at the start.

Many may undertake beekeeping who are, because of lack of physical strength or otherwise, unqualified for other lines of agriculture which require more active, physical effort. Because of the industry not occupying the attention of the beekeeper throughout the year some other occupation should be planned. A fairly good average yield from a colony of bees each season is forty pounds of extracted honey or twenty-five pounds of comb honey.

Selecting the Race.—Wild black or *German bees* are sometimes captured and used in domestic colonies, but as they are very cross, easily excited, and easily overcome by diseases and moths, other breeds are preferred.

Italian bees are much more easily managed and are much more in use than any other race. They are good honey makers, are gentle, and good in protecting themselves against robbers, diseases and moths. They are easily recognized by yellow bands across the body behind the wings. There are usually three such bands.

Other races are Cyprian, Carniolan, Caucasian, and Syrian, all of which are more used in Europe than in America.

Members of a Colony.—In a complete colony there are three types of bees—worker, queen (Fig. 298), drone. Workers secrete the wax, build comb, care for queen and larvæ, gather pollen, gather nectar and ripen it into honey, defend and ventilate hive, and do all work except the egg-laying. The queen lays eggs and does nothing else. Drones, male bees, do no work and have no stings. Toward the end of the season or at close of honey flow they are destroyed by workers.

Getting Started.—A good plan is to buy about three colonies of the best bees from a reliable beekeeper. Each queen should be less than two years of age and the bees free from disease. Each colony should be strong, being composed of one young queen, a few drones and thousands of workers. The combs should have been drawn or have full sheets of foundation. The buyer should see that the frames are wired and that the equipment is modern in every respect. Never buy hives that are not standard in size

as future equipment will be needed and will be difficult to obtain if not standard. Ten-frame hives are usually standard in other measurements. (Fig. 299.) The beginner will also want a good veil, a hive tool, a smoker, a pair of gloves with gauntlets and when honey flow begins he will want a super or more to go above each brood chamber. For increase of colonies he must provide additional hives.

Moving Purchased Hives.—Bees locate their hive very

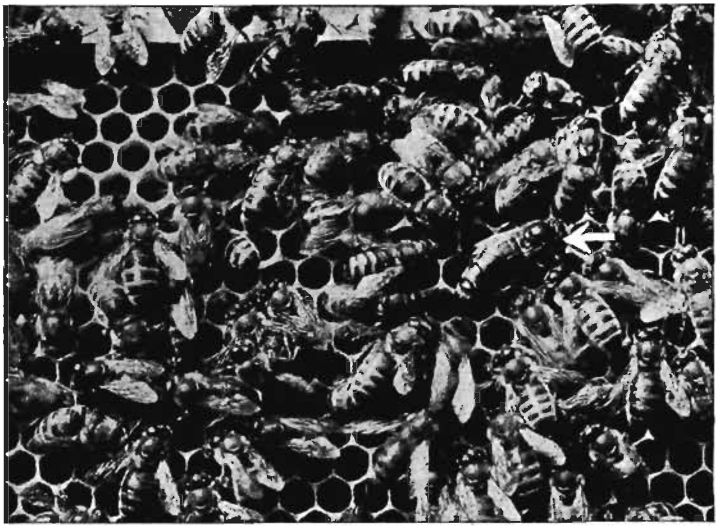


FIG. 298.—Queen bee at white arrow laying in newly made comb; recognized by her greater length and the circle of attendants facing her. (Pellett's Productive Bee-keeping.)

exactly and are disturbed or lost when the hive is moved. To move a hive select a day or night when the bees are all in the hive. Moving a hive several miles is better than moving it only a few rods. When bees find upon emerging from the hive that they are in a new region they will mark the new location well and can return to it accurately. Buy and move the hives in the spring before warm nights prevail.

Locating the Apiary.—In hot climates partial shade is advisable. The exposure should be easterly or southerly. If drainage is poor the hives should be raised a little from the ground. A small platform in front of each hive is advisable.

Two Kinds of Business.—The profits from beekeeping arise from the sale of honey. This may be either (1) as comb honey sold in sections or in chunks, or (2) as extracted honey. **(Fig.**

300.) The beginner should decide which product he will sell. Comb honey sells at a higher price per pound than extracted honey.

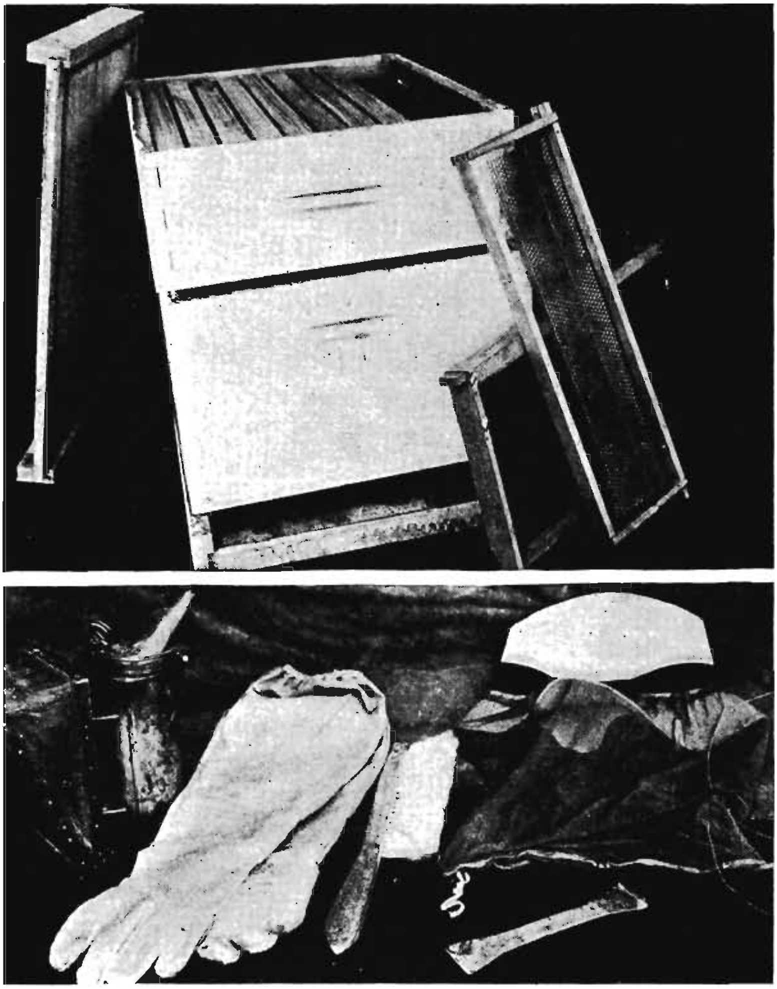


FIG. 299.—Above, standard hive and its parts; below, tools used in bee culture; smoker gloves, brush, veil, and hive tool. (Texas Station.)

A colony of bees, however, will make more pounds of extracted honey in a year, because of not needing to rebuild their combs. The equipment is more expensive for extracting and the beginner may prefer to produce comb honey for that reason.

Experience in Beekeeping.—Many details are involved in keeping bees. These cannot all be learned by reading bulletins and books. Experience is a good teacher, in this case at least. If possible, a beginner should obtain employment in a large apiary for one season before starting a project of his own. He will know then whether he likes the business or not, and will understand the difficulties, advantages, and many details of operation.

Bee Pastures.—Worker bees visit flowers, suck the nectar and store it in honey sacks in their bodies. They fly to the hive, deposit the nectar in wax cells to be evaporated and concentrated by other bees fanning it with their wings. Good nectar-bear-

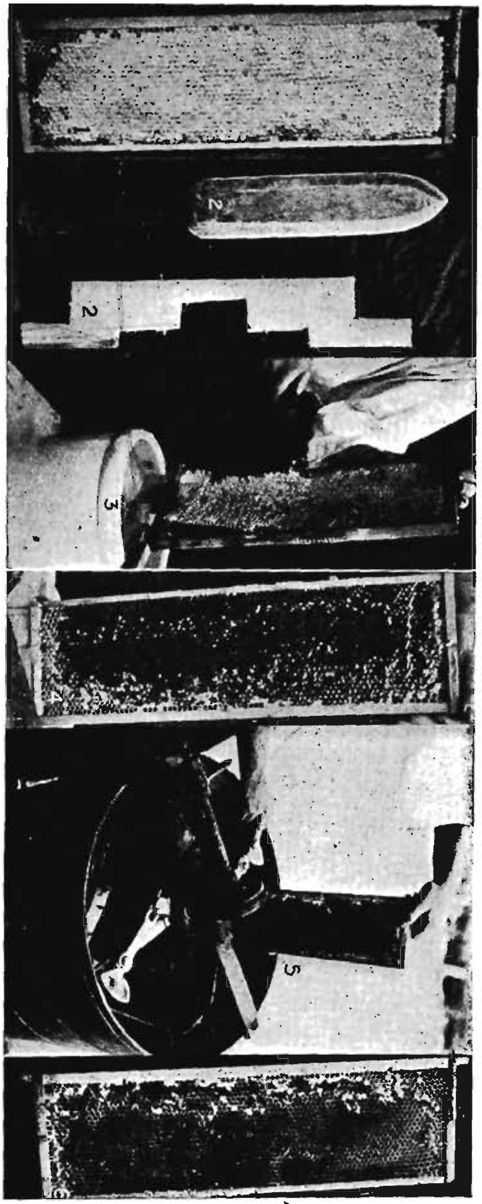


FIG. 300.—Extracting honey. 1, the full super comb. 2, uncapping knife and bar. 3, uncapping cells. 4, uncapped frame. 5, extractor. 6, extracted frame. (Texas Station.)

ing crops are white clover, alsike clover, sweet clover, basswood, locust, fruit trees, buckwheat, golden-rod, dandelion, sunflower, alfalfa in dry sections, aster, melon and cucumber, cotton, maples, willows, smart weed. Many showy flowers bear nectar, and others at least furnish pollen, which is used by bees in brood rearing.

Years differ greatly in nectar flow from the same pastures, depending largely upon the proportion of sunshine and rain. Sometimes nectar is abundant and weather is favorable for bees to gather it. The beekeeper may sow sweet clover, alsike clover, white clover and other crops, and thus plan on having a supply of nectar during the honey season. This should be within easy flight, as long distances greatly reduce the amount of honey stored.

Uniting Weak Colonies.—When spring comes the beekeeper must inspect his hives and discover which ones, if any, are too weak to thrive. (Fig. 301.) If the queen is laying well and there are plenty of worker bees and plenty of honey he may bank on the hive for success. Weaker hives should be united. Absence of brood indicates no queen and if there is no queen the colony will perish. To unite a weak or queenless colony with one having a queen, remove the top from the latter, place a layer of newspaper over it and put the weak colony on top. The bees will eat openings through the paper and move to the lower brood chamber. In a few days remove the paper, smoke down any remaining above, and remove upper body. If honey remains in the upper frames exchange them for empty ones below.

Re-queening.—If a queenless colony has plenty of worker bees and stores it may be re-queened. Get a good three-banded Italian queen from a reputable breeder. Queens are shipped by mail in small cages. Before attempting introduction be sure that the hive is queenless. To introduce a new queen from a mailing cage, follow directions on cage. To introduce one from another hive, there are several methods. One good one is to keep the queen by herself for thirty or forty minutes, in an empty cage; then open the hive quietly, gently puff a little smoke down between frames and let queen run down. Examine the hive a few days later and see if the queen has begun laying eggs.

Spring Feeding.—Watch the hives closely during the cold weather of early spring before nectar-bearing flowers bloom. If the stores are about gone the bees must be fed to save them. Bees should not need feeding in the spring if they go into the winter with about thirty pounds of stores to the colony. They may be fed

in the fall, and a good beekeeper's axiom is "do your spring feeding in the fall."

Sugar syrup may be made by mixing two parts of sugar with one of water. A pan containing the syrup may have a strip of

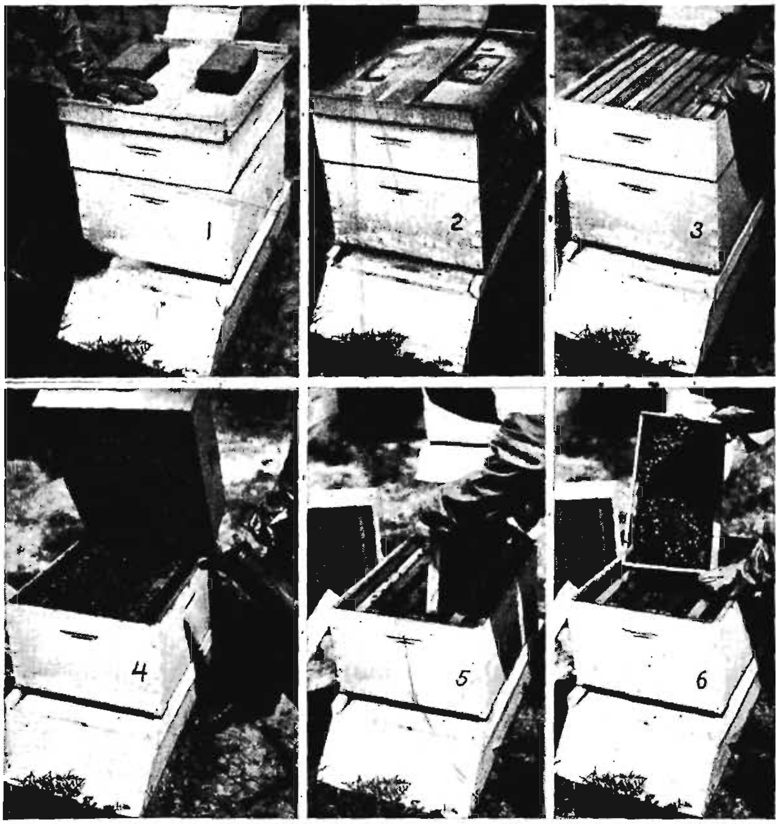


FIG. 301.—Inspecting a bee hive. 1, smoking the hive; 2, removing the top; 3, inspecting super; 4, removing the super; 5, removing brood frame; 6, inspecting brood. (Texas Station.)

cloth placed across it and reaching over the sides. This pan may be placed on the top brood frame with an empty super over it. Bees can thus get the syrup without being drowned. Another device is to use a friction-top can and punch a dozen minute holes close together in the top. Place syrup in this and invert it over the brood combs. Special feeders are sold by dealers in beekeepers' supplies.

Swarming.—In early summer, hives of bees usually become overcrowded because of the natural increase. This brings on a desire to swarm. The old queen goes out with the swarm, leaving several sealed queen cells in the old hive, from which a young queen emerges. Many workers and drones go with the swarm. They usually collect on some object, as a tree near the hive. If an empty hive is ready the queen and most of the bees can be readily taken while quiet and placed near the entrance or directly in the hive. This is accepted as a new home. This method of increase in colonies requires close watching at the season when most of the swarming is done. Carelessness in this results in the loss of swarms.

Clipping Wings.—The queen's wings may be clipped early in the season; then, when the swarm issues, she will usually be found on the ground near the entrance. Put her in a cage or ordinary glass, in shade; remove the hive from the stand and put in its place a new hive fully prepared with combs or full sheets of foundation. When the swarm discovers the absence of the queen it will return to the old location and enter the new hive. Then release the queen at the entrance and allow her to go in among them. The old hive may now be moved to another stand.

Preventing Swarming.—As soon in the spring as the brood chamber is filled add another chamber and put several frames of brood in it. Have the filled frames in both stories in the central part of the hive. Fill the balance with frames containing combs or full sheets of foundation. As swarming time approaches scatter the brood and place empty frames between them. Bees will seldom swarm when they find they are not crowded. Supers may be added as desired to give new space. Some beekeepers cut out queen cells as a means of swarm prevention.

Dividing Colonies.—Another plan practised by experienced beekeepers is to watch when the colony becomes nearly strong enough to swarm naturally. Then remove it from its stand. Place there a hive containing combs or frames of foundation. Remove one or more central frames from the new hive and in their place supply, from the old hive, frames containing brood. Place the queen on one of these in the new hive. If any queen cells are in the new hive they should be cut out. Now place a queen-excluder over this new hive body and place the old hive above it. In a few days examine the upper story to see if there are any queen cells present and if so, this hive body should be removed to a new location. It should not be moved until all larvæ cells have been capped. They will then need no more feeding and can be moved.

If no queen cells are found in it add a new queen to this colony or a rather mature queen cell. If a division is made by this plan, called the Alexander plan, it should be done when bee pasturage will supply the colonies fairly well.

Many practise dividing colonies by dividing brood frames and seeing that a queen cell or queen is left in each.

The Main Product.—Honey to be extracted is stored by bees in supers containing frames of comb or foundation. The brood is excluded from this by using a queen-excluder between it and the hive body. All brood should remain below. As each super is filled another is added to give plenty of storage space. The best comb honey is light in color, the sections evenly and completely filled, and the structure and capping uniform.

Section honey sells much better than chunk honey. It is less easily handled but if good local markets can be secured it brings the highest prices.

Honey is extracted from frames (Fig. 300) by first using an uncapping knife and then placing the uncapped frames in a centrifugal machine called an extractor. Honey is thrown from the outside first and then each frame is reversed and whirled again. Honey collects in an extracting can and is drained out from the bottom, carefully strained through a fine gauze or cheesecloth and placed in suitable containers, sealed and labeled.

Extracted honey is often marketed through coöperative associations formed by beekeepers. In some cases large apiaries place the product in cans of various sizes which may be crated for shipment.

Optional Studies.—Further studies should be made by students intending to pursue beekeeping projects. Include in these studies such topics as diseases, enemies, winter protection, winter food supply, influence of bees on fruit production, and additional information on each of the topics of this chapter.

Surveys, Trips, Skills, Debates, and Projects

1. **Bee Survey.**—If there are many beekeepers in your region make a survey including such points as the following: Number of colonies in apiary; type of hive; size of honey house; chief kinds of bee pasture; race of bees; methods of increasing colonies; ratio of increase; methods of re-queening; methods of feeding; preventing swarming; size of supers; pounds of honey sold; extracted or comb; maximum yield per colony; average yield; method of wintering bees (Fig. 302); diseases; other enemies; remedies.

2. **Debates.**—"Natural swarming *vs.* artificial increase." "Leaving stores *vs.* artificial feeding." "Packing cases *vs.* cellars for wintering." "Packing *vs.* no packing." "Extracted *vs.* comb honey for production." "Coöperative *vs.* other methods of marketing." "Three colonies *vs.* ten colonies for the beginner." "Clipping *vs.* not clipping." "Full sheets of foundation *vs.* starters." Resolved that it is better to work a season

with a large apiary than to start beekeeping with three colonies without experience.

3. **Field Trips.**—Visit large and small successful apiaries to study special methods. This is most valuable during the season of swarming or increase of colonies, *i.e.*, during the honey flow. Study wintering where different methods are followed. Visit apiaries having different breeds of bees and note their differences.

4. **Methods and Skills.**—(1) In a hive, practise finding the queen and locating queen cells. (2) Practise moving brood frames from one brood chamber to another in same hive; if to another hive, watch for

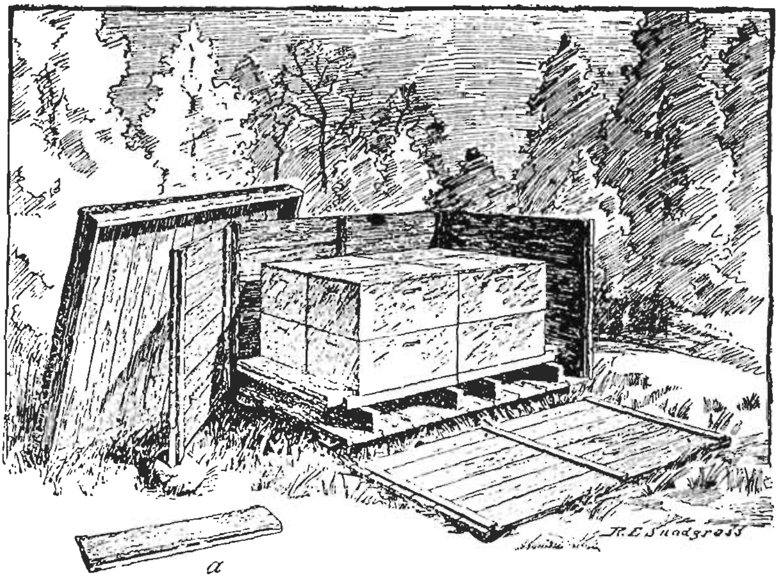


Fig. 302.—The quadruple winter packing case; (a), detail of tunnel to hive. Any type of packing case which gives equivalent insulation on bottom, sides, and top may be used. (U. S. D. A.)

queen. (3) Practise dividing the colony without allowing it to swarm, using different methods. (4) Practise re-queening the hive. (5) Practise feeding a colony by different methods. (6) Practise making hives, sections and frames. (7) Practise putting foundations in frames and sections. (8) Practise wiring frames. (9) Practise capturing swarms and hiving them. (10) Practise cleaning up hives infected with foul brood or containing bee moths. (11) Practise extracting honey from frames. (12) Make winter protection case and pack bees for winter.

5. **Projects.**—Never begin a bee project with less than three good colonies. Ten hives may be better for persons who have had some experience. Begin the project with the early spring season so as to gain practice and experience with all of the spring operations. Let the project continue until the honey is disposed of in the fall or winter. Keep close records of all expenses, labor, yields and prices. The outline, made before the project begins, should include the assembling of hives and parts. Arrange the steps of the project somewhat in natural sequence. List the topics for study and references in bee books where these may be studied.

Questions and Investigations

1. Why is beekeeping so often a side line?
2. Mention your choice of bee breeds. Why?
3. Describe a colony of bees which you would choose if buying.
4. Give cautions regarding moving of hives.
5. Describe a good location for an apiary you have seen.
6. Would you prefer to produce comb honey or extracted honey? Why?
7. How would you try to secure experience in beekeeping before investing heavily?
8. Mention the best crops of your region as sources of nectar. Give color of honey and season for each.
9. Give directions for uniting colonies.
10. How can hives be re-queened?
11. Why do colonies sometimes need feeding in spring? How?
12. Explain swarming and how to hive a swarm.
13. Tell how to prevent swarming.
14. Tell how to increase without swarming.
15. Describe extraction of honey.
16. Give arguments for and against production of extracted honey.
17. Describe attacks of foul brood, moths, or other enemies you have seen.
18. Give several points you have learned from visiting an apiary.

Farm Mechanics.—Make watering devices for bees; wintering boxes for hives of bees; place foundation in frames. Assemble hive parts; make stand bases and roofs; division boards with queen excluders. Repair equipment for extracting honey. Make crates for shipping honey.

Calculations.—1. A beekeeper divides his colonies as evenly as possible placing one-half on the farm of a friend 5 mi. distant where plenty of sweet clover bloom was found. He agreed with the neighbor to pay him for care and pasturage in honey at a minimum of 5 lb. per stand or at 4 per cent of the honey yield if that were greater. How much must be the yield to double the minimum rent? What would be the yield and the rent from 20 stands?

2. If the beekeeper obtained from the 20 colonies at home, a yield only ¾ that of his share from the others, what was his total yield from all?

3. By preventing swarming a beekeeper estimates a 30 per cent increase in honey flow. If his total flow averages 125 lb. per stand from 32 stands and he sells the honey at 20¢ per lb., find his extra income due to swarm prevention.

CHAPTER XXVIII

POWER ON THE FARM

THE chief forms of power used on farms of the present day are animal power, gas engines, windmills, water-wheels and electric motors. Steam is less used than formerly. The use of gas engines for stationary work and for field and road work is increasing rapidly. The harnessing of water power available on many farms by the use of dams and water-wheels is probably increasing somewhat.

Animal Power.—The use of horses and mules is treated in another chapter. Other animal power sometimes found on farms is applied by means of tread mills for stationary work. Cream separators, pumps and other light machines are operated by tread mills where heavy dogs, rams or bulls supply the power. Oxen are still used on many rough farms for hauling timber, clearing logs and other heavy operations. The most even use of horse labor leaves very light work part of the year.

Windmills are economical because of using one of the natural forces. They are suited to nearly all regions but are best for prairie states where wind power is more dependable. Many farmers in other sections find that wind very often fails to blow enough to run the mill many times when it is needed. Other forms of power must then be substituted. The most common use of the windmill is for pumping water from wells, for grinding feed with small grinders, and for running grindstones. Modern windmills differ from the older types in having more speed and requiring less power to turn them. The gearing is changed to suit the pumps and grinders.

Water-wheels.—Large or small streams are often found flowing throughout the year. The owner may determine the fall by taking levels and finding the differences in height of the water surfaces at down-stream points and up-stream points. If two or three feet of fall is found within a reasonable distance and if a suitable place for a dam site can be located, a valuable farm water-power may be harnessed. Dams may be built of cheap materials such as logs or lumber, or concrete may be used if the foundations are good enough to warrant it. Before damming the stream determine approximately the area which will be covered by the impounded water.

A flume or pipe is installed from a good intake point above

the dam and is protected by woven wire or lattice work to exclude floating materials. For sake of economy this flume should be as short as possible but should extend to a point below the dam where a convenient place for installing the water-wheel may be found. This should be well housed in with timber or concrete to avoid damage by high water. For the different types and sizes of water-wheels the student is referred to special books.

The water-wheel may be regularly geared through a system of cog wheels or belts to run feed grinders, pumps and other machines. One of the most convenient, though expensive, plans is to use the water-power to drive a dynamo and generate an electric current, which can be transmitted by wires to the home, barns or other parts of the farm. A dynamo, though expensive at first, is a long-lived machine requiring little skill or care except to keep it lubricated.

Electric power on the farm is gradually becoming more popular. It can be used with safety and economy in lighting homes and other buildings, in running all types of stationary machines, in charging batteries for trucks and automobiles, in heating incubators and in various forms of cooking or heating in the home. Projects in developing or installing complete electrical equipment where conditions are favorable may be undertaken by young people.

Gas and Oil Engines.—These terms are used for the many types of internal combustion machines. They receive their power from the burning of oil or gasoline vapor inside the cylinder. This burning of vapor causes a sudden expansion of gases which moves the piston rod. In turn this movement is transmitted to a crank shaft which operates the fly-wheel. The movement can then be transmitted to the operation of any other machine.

The essential requirements in the correct operation of a gas engine are given: (1) Proper mixture of gas and air. (2) Perfect compression by the piston within the cylinder. (3) Ample spark at the proper time, called ignition. (4) Correct action of valves to let vapor into the cylinder and allow gases to escape. Proper lubrication and cooling are two other essentials.

The carburetor allows vapor and air to mix in the right proportions for quick combustion as they are both drawn into the cylinder by the suction of the piston. The fuel is changed to gaseous form as it is drawn in. When too much fuel is present in the mixture it is called too rich. One effect may be noticed in the black smoke at the exhaust. The range in richness or leanness of mixture is quite limited for successful operation of the engine.

An engine will sometimes run with apparently no bad effects when the mixture is richer than necessary.

Good compression is usually secured if the piston fits the cylinder well. Piston rings are placed around the piston so that it will not allow vapor and air to leak past. These rings when properly lubricated spring closely against the cylinder walls and prevent leaks. When these become worn they may be replaced with new ones.

The ignition system or spark system refers to the devices for igniting the gas in the cylinder for each fresh charge of vapor. The explosion throws the piston toward the opposite end of the cylinder to perform the work of the engine. The lighting or firing of the gas in most modern engines is accomplished by means of an electric spark discharging at a spark plug extending into the gas chamber. The spark is produced through a primary and a secondary coil, the current of the primary coil being produced either by a battery or by a magneto (dynamo).

The jump-spark system uses a high-tension induction coil, the current from which will jump a small gap in a spark plug. This occurs when the electric current from battery or the magneto is interrupted. The spark can therefore be changed in time by changing the position of the circuit-breaker. This is called retarding or advancing the spark.

The make-and-break system uses a simple coil and low-tension current. The interruption of the current causes a hot, flashy spark as the contact points break. This is controlled automatically. The make-and-break method is still common in stationary engines.

Proper valve action in automobiles and other gas engines is accomplished through the careful timing of the opening and closing of valves for each cylinder. A cam-shaft, when properly adjusted, should move the valves to allow the inflow of vapor and air and to let out the gases after the explosion. In stationary engines the inlet valves are self-timed by the suction of the piston which opens them. Read the directions carefully for each engine. Keep the valves free from gummy oil and carbon to prevent leaks.

Starting troubles are more common than other forms of engine trouble as the cylinder may be cold and the fuel not well vaporized. The mixture is likely to be improper, in one way or the other, too rich or too lean. When the cylinder becomes flooded with fuel shut off the supply and empty the cylinder by a few revolutions of the crank or fly-wheel. Try different degrees of mixture until an explosion is obtained. Warming the carbureter

with hot water may aid greatly if the weather is cold. Engines burning oils or kerosene should be started and run until warm by using gasoline or alcohol.

Other engine troubles are usually associated with one or another of the four essentials in operation. One common trouble is lack of lubrication in the engine. If the rings stick they may allow vapor to pass the piston, reducing the compression. Too much oil in the cylinder will give trouble by causing carbon deposit. This is detected by blue smoke from the exhaust pipe. Oil of suitable quality to suit the weather and the engine must be used. Heavier oils may be used in summer and lighter in winter. If oil is supplied by a crank shaft it should be occasionally drained, washed with kerosene and refilled with fresh oil. Get a complete list of engine troubles in Farmers' Bulletin 1013. Look these over carefully to become familiar with the causes of future troubles in engines.

Spark troubles may be easily detected in the jump-spark system by removing a spark plug and laying it on the cylinder and then running the engine a few strokes by hand. If no spark is thus detected, look for the trouble in the wire, in the insulation, in dirty plugs or in the source of the current.

Sizes of Engines.—For the work about the dairy or home and for pumping water small engines are more economical of fuel and are cheaper at the outset. One-horse or two-horse engines are operated cheaper than larger ones. For feed grinding and for the cutting of ensilage, running wood saws and for thrashing, engines should be six-horse-power or larger.

Installing Engines.—The engine always should be placed on a firm foundation, preferably of concrete, and should be firmly bolted down. Place the engine where it will be protected from weather and where the exhaust and oil will not be objectionable.

It may be in a separate room from where the work is done, the shaft or belt extending to where the power is needed. The supply of gasoline or other fuel should be stored in a tank outside, where there will be less danger of explosions. An engine mounted on a low truck may be used in running balers (Fig. 303), silage cutters, feed grinders, irrigation pumps, or other machinery.

Hydraulic Ram.—This is a very simple and inexpensive device for lifting water from flowing springs or other streams to high elevations, as by driving water from a creek in a ravine to the water tank in a barn yard on a hill. (Fig. 304.) If the flow from a spring has a fall equalling two or three feet, within a few rods,

a ram of the proper size can probably be operated. A barrel or other tank, perhaps made of cement, may be placed near the spring or other convenient spot. The pipe extends from the tank to the

Fig. 303.—An engine mounted on a low truck may be used for many farm jobs. Here it is used in baling hay. (Fairbanks-Morse Co.)

ram below. Supply a screen to prevent trash from entering the pipe.

The surplus water from the ram will spill out and run down the stream. From one-third to one-tenth of the water supplied

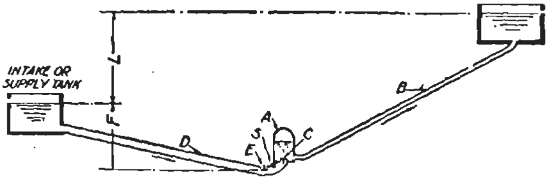


Fig. 304.—General layout of a hydraulic ram installation. D, drive, feed, or supply pipe; E, escape, waste, impetus, dash or clack value; C, check, delivery, or discharge valve; A, air chamber; B, delivery or discharge pipe; S, sniff or air valve; F, fall, supply head, or power head; L, lift, discharge head, or pumping head. (U. S. Farmer's Bulletin 941.)

to the ram is commonly recovered at the tank on the hill. The rest is wasted.

A hydraulic ram requires little attention as the supply of water lubricates it and the action is continuous day and night. When water from a spring is forced to a small tank for house purposes

it is best to install a hot-water tank in the kitchen and equip a modern bath room. The overflow of water from the house tank may run to a dairy trough to cool milk cans. It may then flow

FIG. 305.—Plowing clover sod with a tractor, turning two furrows, each fourteen inches wide and nine inches deep. (Stuart's, The Potato.)

to a watering trough for livestock. From there it may extend to a hog wallow or to a garden for irrigation.

Farm Tractors.—Tractors are used on farms chiefly for heavy work such as plowing (Fig. 305), disking and harrowing. Caterpillar treads are less likely to give trouble on soft plowed fields than others and may be used sooner after heavy rains. Their

FIG. 306.—Tractor drawing two self-binders in harvesting grain. (International Harvester Co.)

slowness in speed may be an objection. The use of tractors in cultivation of crops such as corn has caused manufacturers to devise special implements for this purpose. Some tractors straddle the rows of a crop, while others go between rows. Tillage implements for this purpose till two middles or more at a time. Haymowing attachments are made for some tractors, by which wide swaths are cut in plain view of the operator of the tractor. Other uses of tractors are suggested in figure 306.

Stationary work done by tractors anchored in place and belted

to machines, is usually of the heavy type of farm work, such as cutting of ensilage, thrashing grain, baling hay, and grinding grain.

A few modern tractors have rubber treads on the wheels when they are used for road work. The speed of the tractor for this purpose must be greater than for field work, as it is to take the place of a motor truck in hauling products to market and doing other hauling on public roads.

Surveys, Trips, Exercises, Projects, and Problems

1. **A farm power survey** may include these points: Horse power of tractors; lists of uses; troubles; horse power of stationary engines; their use; troubles; trucks, kinds; uses; troubles; automobiles, kinds; uses; troubles; windmill, size; uses; troubles; electric power, source; uses; troubles; steam engine, size; use; troubles; animal power, number; value; cost of plowing with horses; cost of plowing with tractors.

2. **Problems.**—(1) Compare the costs of plowing by different powers. (2) Compare the annual work of a tractor with the annual work of a team of horses. Include interest on investment, fuel, feed, repairs, and all other expenses. (3) Compute the cost of installing a ram including its purchase, the cost of pipes and labor, taking a local case or an imaginary one. (4) Calculate the percentage of water recovered from a ram when compared with the water supplied to it. (5) Compute the cost of installing a water-wheel and a small dynamo on a stream similar to some local one or one you have seen. Get prices of materials from dealers. (6) Compute the cost of running a one-horse-power gas engine for pumping water or other farm work for one year. (7) Likewise compute the cost of operating a six-horse-power stationary engine doing its farm work one year.

3. **Charts.**—Make a chart showing the items of cost in the installation of a hydraulic ram. On another chart show by a drawing the conditions necessary for the successful operation of a ram. Make a chart of gas-engine troubles; and another of essentials in the operation of a gas engine, with subdivisions of each. Compare on another chart the costs of a year's plowing (1) by use of a tractor and (2) by the use of horse power.

4. **Debates.**—"Large *vs.* small gas engines." "Tractors *vs.* horse power." "Steam engines *vs.* gas engines for stationary work." "Windmill *vs.* gasoline engine for pumping water."

5. **Field Trips.**—Visit farms where various forms of power are in use and study the equipment, its uses, and learn from the owner the troubles, advantages and disadvantages. Visit supply houses to study different forms of engines, tractors, automobiles, electrical equipment, windmills and hydraulic rams. Visit farms when various forms of power are being installed. Take levels on streams and calculate the possibilities of installing water-power and dynamos. Take levels on flows from springs and calculate the possibilities of lifting water by hydraulic rams. Calculate the sizes of pipes and rams to be used in each case. Get catalogues of rams from firms advertising in agricultural journals.

6. **Exercises.**—Schools not owning gas or steam engines may be able to borrow these from dealers or farmers. Good exercises with these consist of starting and stopping, locating troubles, repairing, supplying new parts, adjusting parts, and study of oils and fuels.

7. **Projects.**—A good student's project may be planned in the use of a tractor for a year in doing farm work for the home farm and for

neighbors. The profits may be calculated on the basis of work done either by the job, by the hour or otherwise. Projects may be planned consisting of the installation of water-power, lighting systems and other equipment.

Questions and Investigations

1. What forms of farm power seem on the decline, and what on the increase, in your region?
2. Would you prefer heavy horses or light horses for farm use? Why?
3. Describe a dam and water-wheel installation which you have seen.
4. Give the benefits of electric power on the farm.
5. Give four essentials for correct operation of gas engines.
6. Why is the adjustment of the carbureter important?
7. Why is good compression necessary?
8. Describe a spark system which you have examined.
9. What conditions may interfere with the proper valve action. Give remedies.
10. How can engine troubles be most easily located?
11. Discuss sizes of engines for farm use.
12. Give directions for installing a heavy engine.
13. What conditions are essential for the operation of hydraulic rams? Give their benefits.
14. What points would you consider in deciding whether or not to purchase a farm tractor?

References.—U. S. Farmers' Bulletins: 1045, Tractor plowing; 1448, Farmstead water supply; 1658, Farm water power. JONES: *Farm Gas Engines and Tractors* (McGraw Hill, 1932), $4.

Farm Mechanics.—Repair or replace engine parts, as spark plugs; fan belt; starter spring; battery; generators; radiator; piston rings. Grind valves. Mend belts in shop; install pulleys and shafting; make stationary engine block of concrete.

Calculations.—1. A gasoline motor has a 5-in. pulley running at a speed of 200 revolutions per minute. The owner wishes to operate a feed mill at a speed of 50 revolutions per minute. What should be the diameter of the belt pulley wheel on the mill? Two pulleys are equal in their products of speed times diameter.

2. Farmer, A, owned a wood saw for cutting fuel, valued at $35. His neighbor, B, owned a gas engine valued at $70 which could be operated at a cost for gas and oil of 25¢ per hour. They wish to cut equal amounts of fuel for both families. Both men work equally on both jobs and the owner of the wood pays for the gas and oil while cutting his own wood. If the life of the saw is 1,400 working days and the life of the engine is 700 working days, determine a fair basis of pay for use of each machine.

3. C and D each have good wells and pumps located near the centers of their farms where 4 fields meet. C's pump is operated at an expense of $5 a year by a windmill with storage tank. They cost $105 and are estimated to last 25 years. D's pump is operated at an expense of $50 a year by a gas engine which cost $45 when new and should last 6 years. Compare the total costs on each farm for 6 years, not considering labor.

CHAPTER XXIX

FARM SHOP WORK

THE farmer should understand how to do many things in a little room which he may call the farm shop: iron welding and shaping, sharpening farm tools, wood work, pipe fitting, tin work, soldering, cement work, electric wiring, rope work, belt splicing, harness repairing, painting, the repairing of gas engines, tractors and machines.

The farm shop may be some room in some farm building,

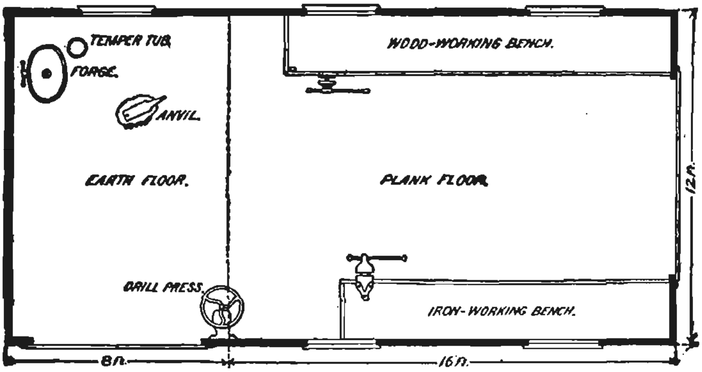


FIG. 307.—Floor plan of shop for a farm. (U. S. D. A.)

such as the corner of the barn, or it may be a special structure for the purpose. The latter is better. (Fig. 307.) If possible, have the doorway large enough to take in a binder or a wagon for repairing and painting. Have a good place where tools may be kept in neat order and may be locked up. A cheap forge in one corner may have a pipe to conduct smoke away through the chimney. Have a good work bench (Fig. 308) with iron vise and another with a wood vise. A harness jack may be made or purchased. A pipe vise may be in the jaws of the iron vise or may be separate. Provide good tools but keep the number down to the lowest minimum possible. A tool grinder should be mounted in a light place. Many tools for iron work may be made in the shop.

Make articles in your home shop which are suitable for farm projects. You may, perhaps, build your own shop and benches, and make your own forge. You can also make shop saw-horses,

FIG. 308.—Students at work in farm shop course, making things for their farm projects. This form of bench, made by students, is 3 by 6 feet, with oak top, and a slide vise on each side. Two students use the bench.

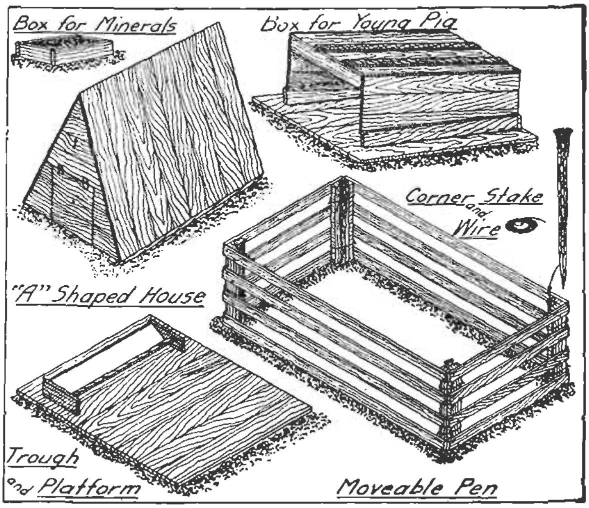


FIG. 309.—Useful equipment for a successful pig business. (New Jersey Station.)

bench hook, bench stock, mitre box, tool chest, nail box, hooks, and tool holders.

For lists of tools see shop books in references at close of this chapter.

Things to Make in Cattle and Dairy Projects.—Feeding cart, grain bunk, hay rack, milk stool, board for record sheet, dehorning chute, dipping vat, calf feeding troughs and stanchions, sheds, milk room, water trough for milk cans, bull stall, concrete fence posts, butter paddle, butter print, butter tray, cream ladle, stirring paddle.

Things to Make in Swine Projects.—(Fig. 309.) Hand hurdle, shipping crate, show pen, feed trough, feed hopper (Fig. 310), hog rack, loading chute, concrete water trough, concrete feeding floor, movable cot for sow and litter (Fig. 311), concrete wallow, dipping vat, stationary hog house, movable fence panels, pasture fence, alfalfa rack, cutting table, gammon stick, butcher rack.

Things to Make in Horse Projects.—Box stalls, other stalls, floor grading, feed boxes, mangers, hay chutes, hay racks, gates, doors, rope halters, harness mending, hobbles, breeding pen.

Things to Make in Sheep Projects.—Shelter, grain feeder, hay rack, water trough, shearing table, woolframe, butcher block, dipping vat, lambing pen, lamb creep, folding panel, hand hurdle.

Things to Make in Poultry Projects.—Dry mash hoppers for chicks and hens, coop for natural brooding, exhibition coop, artificial brooder, brooder house (Fig. 312), movable laying house, permanent house, concrete floors, shipping crate, fattening crate, feeding trough, trap nest, poultry fence, poultry gate, coop for brooding hens, egg candling box, shipping crate for eggs.

Things to Make in Bee Projects.—Making or putting together knock-down supplies for bees: base, bee-hive, super, top, observation hive. Place foundation, make bee net, hive tool, frame, section, shipping cases for honey, feeder, ladder, honey house, packing case for wintering, outside walls for winter hives, concrete cellars for wintering, exhibition shelves.

Things to Make in Fruit Projects.—Grafting bench, labels, stakes, hand dibber and planting board, storage box for grafts, picking ladder, sack holder, shipping crate, spray tower, apple box, fruit picker, barrel press, sorting table, strawberry runner cutter, tray for picking boxes, packing shed, market wagon rack, trellis.

Things to Make in Garden Projects.—Hotbed, coldframe,

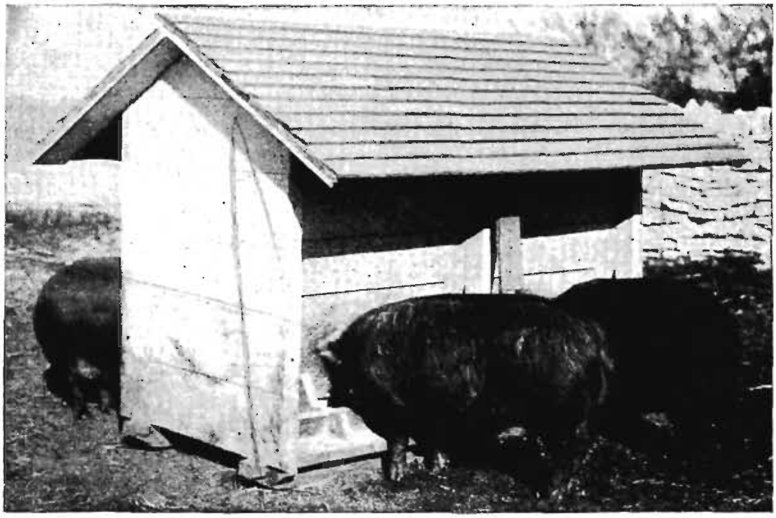


FIG. 310.—A self-feeder with four compartments, two on each side. A wide roof helps save the feed. (Kansas State Agriculture College.)

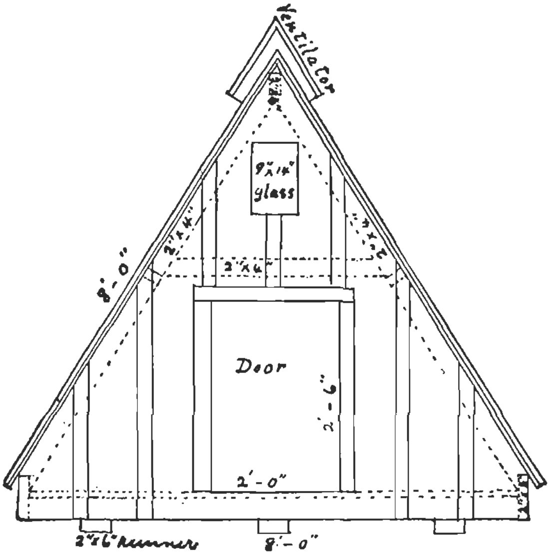


FIG. 311.—Front view of A-shaped house for sow and litter. (Day's Productive Swine Husbandry.)

compost screen, hand dibber, flat, stake, label, twine winder, asparagus knife, soil packer, plant stake, trellis, hand markers, horse marker, planter, shipping crate, hand cart.

Things to Make in Field Crop Projects.—Bushel crate, two-

FIG. 312.—A movable brooder house for baby chicks under construction—outdoors near the barn.

and three-horse eveners (Fig. 313), neck yoke, wagon reach, wagon tongue, wagon jack, ladder, farm gate, wagon box, wagon seat, hay rack, hay stacker, seed tester, seed-corn drying rack, sack

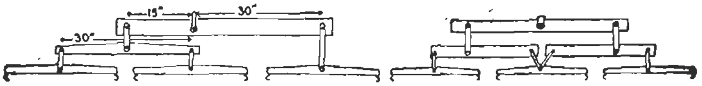


FIG. 313.—Two forms of three-horse eveners.

holder, potato grader, drying pole for peanuts, shock support, fork rack, rat-proof bin and crib, sled for hauling plows.

Other Things to Make.—Garage, concrete septic tank, water supply system for kitchen or bathroom (Fig. 314), wash bench, work table, window screen, plant stand, broom holder, bread board, ironing board, fly trap, fireless cooker, iceless refrigerator, surveying pole, rod, and tripod, ditcher's square, water level, mount for carpenter's level, straight edge, wood sawing frame, blue print frame, saw setting holder, road drag.

Leather Work.—Equipment for sewing harness (Figs. 315

and 316) is inexpensive or may be mostly made at home. Practise mending harness for yourself and neighbors. A project may be undertaken to do jobs of this kind for a compensation for one school year. Also practise splicing and lacing leather belts. Dress-

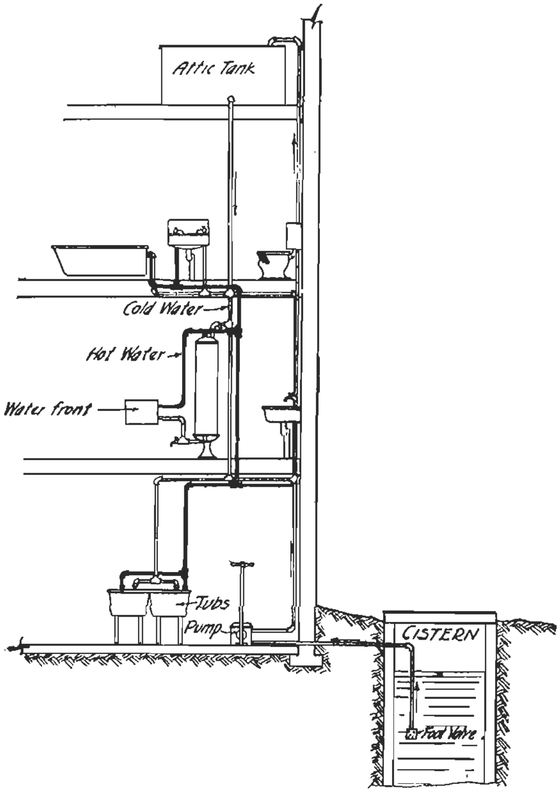


Fig. 314.—Gravity water supply system with attic tank This system is well adapted to laundry purposes but water stored in an attic tank is not fresh enough for drinking. The hand pump is most common; and it is inconvenient to have an attic tank large enough to supply the toilet. (U.S.D.A.)

ing for leather should be available and should be used. If shoe mending is undertaken, make a suitable seat, bench and tool holder.

Soldering.—A soldering outfit will quickly pay for itself if used at home. Practise soldering metals of various kinds, particularly the repairing of tinware, until able to do good, smooth work. Carefully follow directions given in shop books.

Glazing.—Practise cutting glass of definite sizes from scraps.

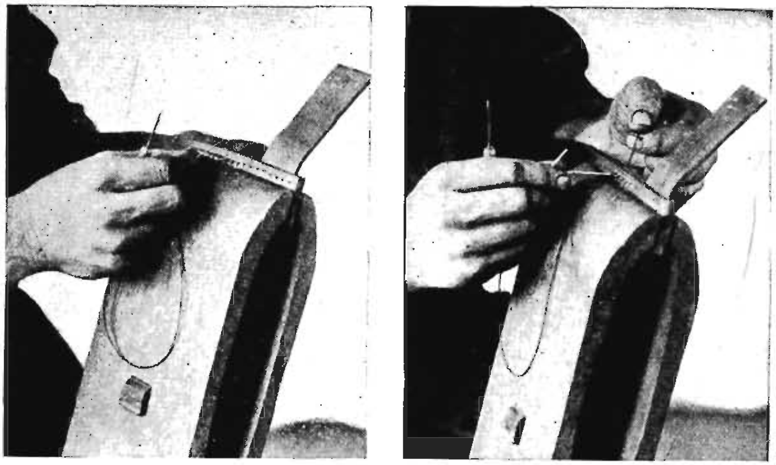


Fig. 315.—Stitching a loop to a strap using a harness clamp. A, the left-hand needle has been entered and is ready to be pulled through. B, the left-hand needle is through, the right-hand needle is entered, and the left-hand thread is pulled back to help the needle through. (Cornell Reading Course, Lesson 160.)

Fig. 316.—Frequent cleaning and oiling and timely repairing of harness combine to add many years to its life. (Cornell Reading Course, Lesson 160.)

Glaze window sash and hotbed sash. Practise manipulating putty and use it in such work.

Pipe Fitting.—With a pair of pipe wrenches and a few dies and stock, practise fitting pipes in small jobs about the place. Repair water pipes; install water pipes. Over the kitchen sink install a kitchen pump to draw water from the cistern or well; install a hot-water system. (Fig. 317.)

Painting.—Practise painting first on surfaces that have never been painted. Learn to brush well into the grain of the wood. Practise mixing white lead and oil to the proper consistency. Practise mixing dry paints with oil and lead. Practise mixing colors. Study drying effects of different mixtures and certain ingredients, such as turpentine. Compare the effects of raw linseed oil and boiled oil. Test brushes of different shapes, fibers and lengths.

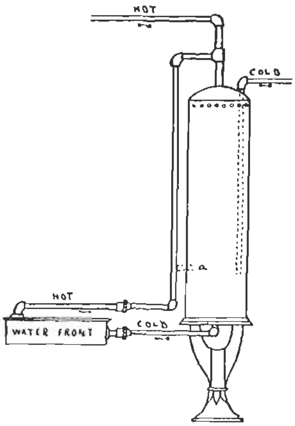


FIG. 317.—Pipe connections for hot water system. Hot water may be drawn as soon as the fire starts. The pipe, dotted at (a), often used by plumbers, should be omitted.

Tool Sharpening.—On a tool grinder learn to sharpen chisels, hatchets and axes without heating them. Practise grinding tapering edges that have been made too blunt. Practise filing saws of different sizes and types of teeth. Learn to joint them with a flat file to straighten the surface-cutting tips. Practise setting saws.

Repairing Farm Machinery.—Old machines which need repairing should be thoroughly overhauled. Mend some parts and purchase others. Paint all wooden parts and metal parts that are not to be polished. Oil polished surfaces to prevent rusting while in storage.

New machines may be loaned by dealers or farmers for practice in adjusting parts and learning manipulation. Students may visit storage place of dealer for this purpose. (Fig. 318.)

Points to be learned in the care of farm machinery: (1) Constant attention and repair in time. (2) Oil machine bearings when in use and also when placed in storage. (3) Grease polished surfaces when stored. Wagon grease is good for this. (4) Keep machines well painted. (5) Keep machinery housed when not in use.

Rope Work.—Fibres such as cotton and hemp are used in spinning ropes. The fibres are first spun to the right into yarns. Yarns are twisted to the left to form strands. Three strands

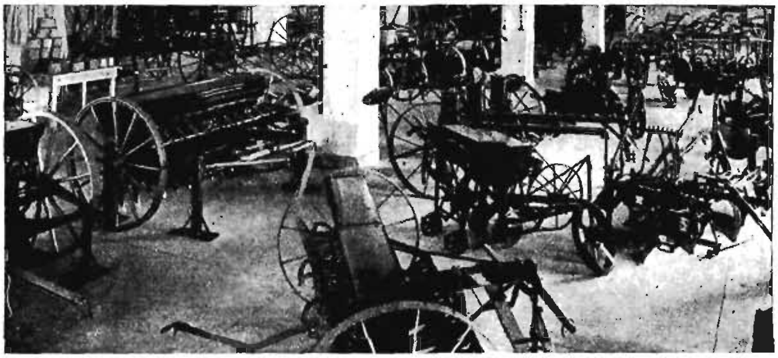


Fig. 318.—Farm machinery at sales places of dealers may be used by students to learn to assemble parts, make adjustments and compare structures. (International Harvester Co.)

twisted to the right are used to make a common rope. Sometimes three common ropes, or hawsers, are twisted together to the left to form a cable. This reversal in the order of twisting each time

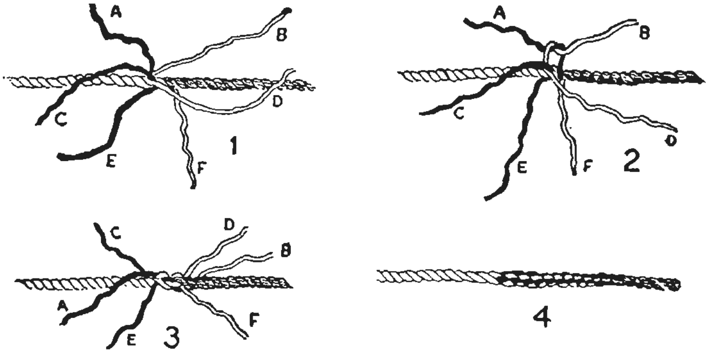


Fig. 319.—Four stages in making the short splice. 1, the six strands of the two ropes arranged in pairs, A-B, C-D, E-F. 2, A-B tied with first overhand knot. 3, each of the three pairs tied likewise. 4, completed splice.

aids in keeping the rope or cable from untwisting. The closeness or tightness of twisting largely governs the strength. Get a bulletin on rope work from Cornell or from the Minnesota or the Iowa Station and practise tying the square knot, surgeon's knot, bowline, timber hitch, clove hitch and others.

The short splice is used to quickly splice two pieces together. All of the strands are intertwined at one place, making the rope twice as large at this place. It is, therefore, not suited for use with a pull y. About three inches of rope on each piece are required for a quarter-inch rope.

First unlay the three strands of each piece about three inches. Put the ends of the rope together as shown at 1 (Fig. 319). Pair the six strands so that each strand pointing to your right is adjacent to a strand beyond it, pointing to your left as D nd C. Tie a first over-hand knot with two pairs as shown at 2, A-B. Then with the third pair continue to wrap each strand around its mate only. Continue in both directions until

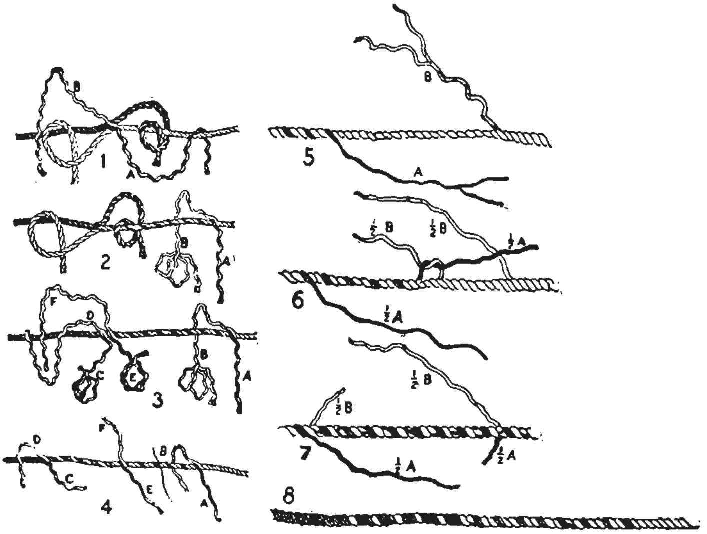


Fig. 320.—Long splice showing eight stages or steps in the operation. (Steps 1-4 after Riley.)

the ends are nearly used up. In doing the wrapping keep the strands tightly twisted as when the rope was first made. Do the same with each of the other pairs of strands. This wrapping should take the direction of the natural twist of the rope. Trim off all surplus ends at the finish as shown at 4.

The long splice is suited for ropes that are to be used with pulleys. Use it for well ropes, hay ropes and derrick ropes. More rope is consumed in the long splice than in the short splice. For each one-fourth inch of diameter of rope allow about nine inches on each of the two ends to be spliced together. For one-inch rope use about three feet from each end. First unlay one strand from each for the required distance. Bring the ropes together at this point as shown at 1, figure 320. Hold the ropes at this point with the left hand and with the other temporarily twist two of the pairs or tie them to keep them paired, as shown at 1, in the figure. Now with the right hand unlay strand B from the right-hand rope, and lay strand A snugly in its place, working some distance to the right as shown at 2.

Next unlay C shown in 3 and lay D snugly in its place, 4, working toward the left (unless you wish to reverse the rope). The longest ends are trimmed off somewhat as shown at 4.

The remainder of the splice is practically the same for the remainder of the three pairs. *Let us consider the pair A-B only.*

Unlay B-C three inches (for quarter-inch rope), without following with A, shown at 5. Now split each strand of A and B and twist a half strand of each firmly and lay these in the vacant channel until they meet midway. Tie these together with a common overhand knot, as shown at 6 and draw snugly. The rope is now less than full size. This part of the rope is now to be made full size by wrapping each half-strand ½A and ½B around its mate continuously until it is used up or passes the point of division, shown at 7. These four half-strands may now be trimmed close to the rope. Next finish the pairs C-D and E-F in the same way and the rope will have the appearance shown at 8.

Now to recapitulate, you will note that the pair A-B was carried to the right to work; the pair C-D was carried to the left to work; so the pair E-F has to finish in the centre (as shown at 4). To do this the strands E and F will each be unlaid one-half distance before splitting the strands.

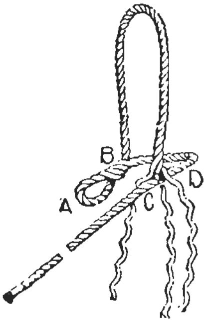


Fig. 321.—Rope halter showing construction. (After Riley.)

A rope halter may be made quickly in case a leather halter is not available. With a little practice in rope splicing, a person can make a good rope halter by studying figure 321. Practise a few times before necessity arrives. Form the halter over the knee while sitting down, so as to get reasonable dimensions. First decide where the eye, A, is to be made. At B raise the top strand of the rope and pass the short end of the rope through it toward the left. Then raise the top strand of the short end at A and pass the long end through it towards the right. Unlay the short end to C and pass the middle strand under the outer strand of the main rope at D. Raise the next strand of the main rope and pass the lower end through it. Now complete the splice by continuously passing each of the three strands around its mate in the rope. The long end of the rope is then run through the eye of the halter.

Surveys, Charts, and Projects

1. **Survey.**—An equipment and shop survey should include such points as the following: Kind of place for farm shop; tools for leather; for iron work; for soldering; for pipe fitting; for grinding tools; for wood work; for painting; for concrete; for running levels; kitchen sink and drain; hot-water system; source of water supply; storage for water pressure; size of septic tank; bathroom equipment; lighting possibilities; cement work done; conditions of paint on buildings; repairs of buildings; housing of machinery; approximate value of farm machinery; age of oldest useful machine; size of largest barn; amount of farm terracing; acres under irrigation.

2. **Charts.**—(1) Draw on a chart a good floor plan of a farm shop showing the location of main equipment. (2) Make a list of tools you would advise for farm shops of your region. (3) Show items of cost for materials and equipment of a bathroom, omitting labor.

3. **Projects.**—On a well-equipped farm a young man can undertake the project of placing the machinery in repair and keeping it so for a year. Figure the profit either on the time basis, or on the basis of the cost for the year before, or the year after, when work is higher. (2) Construct a farm shop, make the benches and much other equipment and purchase other necessary tools. (3) Plan and install an irrigation system

of a suitable type. (4) Install bathroom equipment. (5) Install a kitchen sink and its drain to a septic tank or elsewhere. (6) Undertake the repairing and painting of the residence and farm buildings and fences. See other subjects for projects in *How to Teach Agriculture,* Storm and Davis, p. 297.

Questions and Investigations

1. Describe a good farm shop which you have seen.
2. What should be the chief equipment?
3. List a number of things for farm shop work connected with dairying.
4. List the most important swine project articles to make. The same for poultry projects.
5. The same for bee projects and fruit projects.
6. The same for garden projects and field crop projects.
7. Suggest good leather exercises for the farm shop.
8. Tell how to solder a hole in a tin vessel.
9. Give directions for cutting glass and puttying.
10. List eight fittings used in pipe work.
11. Mention driers for paint.
12. Why should lead be an ingredient of most paints?
13. Give directions for upkeep of farm machinery.
14. Give a list of knots you can tie with your eyes shut.
15. What are the benefits of the short splice?
16. What are the special uses of the long splice?

References.—U. S. Farmers' Bulletins: 847, Potato houses; 1078, Ice houses; 1214, Dairy houses; 1448, Water supply; 1535, Horseshoeing; 1590, Fire protective construction; 1582, Making cellars dry; 1622, Rural buildings; 1638, Rat-proofing buildings; 1649, Chimneys and fireplaces; 1658, Farm water power; 1660, Using logs and poles; 1667, Fire department; 1669, Terracing. See references in each chapter for suggestions. *Concrete on the Farm,* Atlas Portland Cement Co. (free). *Hundred Handy Helps* (Southern Pine Assn.). *Rope, Knots and Splices* (Int. Harv. Co.). FOSTER and CARTER: *Farm Buildings* (Wiley, 1928); BOWEN: *Dairy Engineering* (Wiley, 1925); SHARP and SHARP: *Farm Mechanics* (Wiley, 1930); FIELD-OLSON-NYLIN: *Farm Mechanics* (Century, 1928); BOSS-DENT-WHITE: *Mechanical Training* (Bruce, 1931).

Farm Mechanics.—Make cabinet to hold nails, screws, and other hardware. Make or repair benches; sawhorse; shelves for paints and other supplies; tool case; tool box; lumber rack; pipe and iron rack; saw clamp. Mount vise; anvil.

Calculations.—1. A student while attending school made a number of articles of equipment for his project with poultry. By consulting a poultry supply catalog he found he had avoided the purchase of feed hoppers valued at $15, fattening battery $32, catching crate $3, brooder $16, delivery case $1.50. He found his materials purchased had amounted to only 15 per cent of the total of these items. Find his saving over cost of materials.

2. The above student built a portable laying house valued at $85, fences and gates, $32; roadside sign, $3; shipping crates, $20; water-pail protector and stand, $3.50; record holder, 50¢; catching net and hook, $1; brooder house, $40. He found the material had cost 40 per cent of the value of these. Find the amount spent for materials and the value of the property he had accumulated in problems 1 and 2.

3. Make similar problems with other farm projects.

4. If the average farm mower costs $90 and lasts the owner 11 years, cutting 60 acres a year, what is the cost per acre for mower use? Allow 6 per cent interest on first cost.

APPENDIX

INSECTICIDE AND FUNGICIDE FORMULAS

Poisons for Biting Insects

1. Arsenate of lead (powder) on apple, $1\frac{1}{2}$ pounds to 50 gallons of spray: on peach, 1 pound to 50 gallons of spray.

2. Arsenate of lead to be dusted on garden and orchard plants, 1 pound powder to 6 to 10 of lime dust, sulfur, etc.

3. Paris green spray, 4 to 6 ounces and 1 pound lime, to 50 gallons.

4. Paris green to use as dust: 1 pound to 20 pounds lime dust.

5. Arsenite of zinc is to be used one-third as strong as arsenate of lead and then only with sprays containing lime to prevent burning of foliage.

Contact Sprays for Sucking Insects, as Aphis

6. Oil emulsion:

Strong hard soap, shaved fine..	1 pound
Water	1 gallon
Kerosene or crank-case oil....	2 gallons

Dissolve soap in boiling water and then add other parts. Agitate violently while hot, by pumping over twice. Use 1 part to 30 water as winter spray.

7. Nicotine sprays:

Nicotine sulfate solution	1 part
Water or spray mixtures (Fig. 322)	800 to 1000 parts

8. Tobacco decoction:

Tobacco stems	1 pound
Boiling water	1 gallon

Boil together for one hour and strain before spraying; add water to make 2 gallons.

9. Carbolic acid emulsion:

Strong hard soap, shaved fine ..	1 pound
Crude carbolic acid	1 pint
Boiling water	1 gallon

Agitate and make as directed for kerosene emulsion. Dilute 1 part to 30.

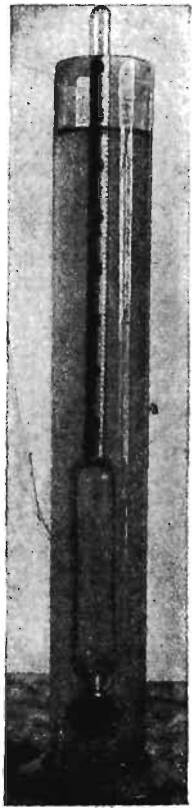


FIG. 322. — Hydrometer and cylinder for use in testing the density of lime-sulfur, scaled by the Baumé standard. Winter strength of lime-sulfur should test about 5 degrees, summer strength 1 degree.

10. **Commercial lime-sulfur** in liquid should be diluted as follows according to the test with Baumé hydrometer:

Baumé reading	No. parts water to add for each part of lime-sulphur: Winter spray to test 5° B.	Summer spray to test 1° B
33	7	40
32	6½	38
31	6	36⅓
30	5½	34¾
29	5¼	33⅓
28	5	32
27	4¾	29⅔
26	4½	28½
25	4¼	26⅔
24	4	25⅔
23	4	23½
22	3¾	22¼
21	3½	20½
20	3	19

11. **Home boiled lime-sulfur,** old formula:

Powdered flowers of sulfur	15 pounds
Freshly burned stone lime	15 pounds
Water to make after boiling	50 gallons

Slake the lime to a thick paste, sift in the sulfur and mix until wet, add a part of the water and boil 40 to 60 minutes. Dilute to 50 gallons for use and make it test 5° Baumé, for winter use on scale and disease spores.

12. **Home boiled lime-sulfur,** common formula:

Powdered flowers of sulfur	30 pounds
Fresh burned stone lime	15 pounds
Water about	15 gallons

Make as directed for No. 11, and test before using. Lime-sulfur preparations may be stored if covered with oil to prevent evaporation.

13. **Self-boiled lime-sulfur,** 8-8-50 formula:

Powdered flowers of sulfur	8 pounds
Freshly burned stone lime	8 pounds
Water to make	50 gallons

Slake the lime to a paste, sift in the sulfur and stir until wet. Add more water slowly. The lime should produce enough heat to boil the mixture several minutes. When all the water is added, strain and use. It is a summer spray for peach and other stone fruits.

14. **Self-boiled lime-sulfur,** recent formula:

Superfine sulfur	4 pounds
Good quality finisher's hydrated lime	8 pounds
Casein "spreader" powder	4 ounces
Water	50 gallons

For the same purposes as No. 13.

15. **Powdered lime-sulfur** is sold in commercial form on the theory that it will save shipment of water. But the prices show it to be much the most expensive form to use. Some of its preparations are not effective against San José scale as recommended.

Fungicides for Plant Diseases

16. **Bordeaux mixture,** common 5-5-50 formula:

Copper sulfate (bluestone) .... 5 pounds
Freshly burned stone lime .... 5 pounds
Water .... 50 gallons

(1) Dissolve the copper sulfate at the rate of 1 pound to 1 gallon of water. (2) Slake lime and add water to make 1 gallon to 1 pound of lime. These may be covered and kept separately as stock solutions.

To make the Bordeaux mixture, dilute each as much as convenient before pouring them together. Pour the two diluted solutions at the same time into a third vessel. Strain, and use immediately. It is a good summer spray for potatoes, tomatoes, apples, etc., and is usually supplied with arsenate of lead or other poisons to fight insects at the same time. Fig. 203.)

17. **Formaldehyde fumigation:**

Formalin, 40 per cent strength .... 3 pounds
Potassium permanganate .... 23 ounces

For 1000 cubic feet of space in a tight room. Used for potatoes, onions, etc., in storage. Put materials in flat, open vessels on floor, leave promptly and close all openings well.

NUMBER OF SHRUBS OR PLANTS FOR AN ACRE

Number of Shrubs or Plants for an Acre

Distance apart	No. of Plants	Distance apart	No. of Plants	Distance apart	No. of Plants
3 x3 inches	696,960	4 x 4 feet	2,722	13 x13 feet	257
4 x4 "	392,040	4½x 4½ "	2,151	14 x14 "	222
6 x6 "	174,240	5 x 1 "	8,712	15 x15 "	193
9 x9 "	77,440	5 x 2 "	4,356	16 x16 "	170
1 x1 foot	43,560	5 x 3 "	2,904	16½x16½ "	160
1½x1½ feet	19,360	5 x 4 "	2,178	17 x17 "	150
2 x1 "	21,780	5 x 5 "	1,742	18 x18 "	134
2 x2 "	10,890	5½x 5½ "	1,417	19 x19 "	120
2½x2½ "	6,960	6 x 6 "	1,210	20 x20 "	108
3 x1 "	14,520	6½x 6½ "	1,031	25 x25 "	69
3 x2 "	7,260	7 x 7 "	881	30 x30 "	48
3 x3 "	4,840	8 x 8 "	680	33 x33 "	40
3½x3½ "	3,555	9 x 9 "	537	40 x40 "	27
4 x1 "	10,890	10 x10 "	435	50 x50 "	17
4 x2 "	5,445	11 x11 "	360	60 x60 "	12
4 x3 "	3,630	12 x12 "	302	66 x66 "	10

Morrison's Feeding Standard[1]*—Nutrients Needed*

	Digestible Protein	Total Digestible Nutrients
	lbs. Average	lbs. Average
Maintenance for 1000-lb. cow[2]	0.700	7.925
Maintenance for each 100 lbs. live weight	0.070	0.7925
To allowance for maintenance add as follows:		
For each 1 lb. of 3.0% milk	0.052	0.271
For each 1 lb. of 3.5% milk	0.055	0.300
For each 1 lb. of 4.0% milk	0.059	0.328
For each 1 lb. of 4.5% milk	0.063	0.357
For each 1 lb. of 5.0% milk	0.066	0.382
For each 1 lb. of 5.5% milk	0.070	0.406
For each 1 lb. of 6.0% milk	0.074	0.431

[1] Morrison's Feeding Standard was devised by F. B. Morrison of the Wisconsin Station and is published in "Feeds and Feeding" by Henry and Morrison.

[2] Maintenance is the quantity of nutrients needed daily to keep the animal alive and functioning properly at same weight without work or putting on flesh.

To balance a daily ration obtain weight of cow, and find her maintenance requirements. Calculate the protein and total nutrients needed for her milk production and add to the maintenance.

Average Composition of Commercial Fertilizing Materials

(Relative availability, given as q, quick; s, slow; m, medium; v, very.)

Nitrogen Carriers	N%
Cottonseed meal (s)	6
Dried blood, black (m)	6–12
Dried blood, red (m)	13–14
Dried fish (s)	7–9
Dried meat meal (s)	13–14
Nitrate of soda (q)	15–16
Sulfate of ammonia (q)	20–21
Tankage (s)	6–9
Tobacco stems (m)	1.5

Phosphoric Acid Carriers	P_2O_5%
Superphosphate (q)	14–20
Basic slag (s)	15–20
Bone meal, acidulated (q)	12–16
Bone meal, steamed (m)	25–30
Cottonseed meal (s)	2.8
Dried fish (s)	6–9
Hardwood ashes, unleached (m)	2.4
Rock phosphate (v. s.)	18–32
Tankage (m)	3–8
Tobacco stems (m)	1.5

Potash Carriers	K_2O%
Cottonseed meal (s)	2.5
Hardwood ashes, unleached (m)	5.7
Kainit (q)	10–13
Muriate of potash (q)	50
Sulfate of potash (q)	48–50
Sulfate of potash (low) (q)	25–28
Tobacco stems (m)	6

Lime Carriers	CaO%
Basic slag (m) old process	40–60
Basic slag (m) new process	0–5
Bone meal, steamed (s)	30–40
Burned lime, fresh (q)	90–100
Ground lime rock (s)	45–50
Hydrated lime (m)	65–70
Marl (s)	20–40
Oyster shells, ground (s)	40–48

Digestible Nutrients and Fertilizing Values of Feeds

Name of feed	Dry matter in 100 lbs.	Digestible parts in 100 lbs.			Fertility in 1000 pounds		
		Protein	Carbo-hy-drates (+fat ×2.25)	Total Nu-trients	Nitro-gen (N)	Phos-phoric acid (P_2O_5)	Potash (K_2O)
Alfalfa, green	28.2	3.6	13.0	16.6	7.7	1.3	5.6
Alfalfa, hay	93.6	11.7	43.1	54.8	26.1	6.1	17.9
Barley	89.2	8.4	68.9	77.3	19.2	7.9	4.8
Beet pulp, dry	91.6	4.1	65.1	69.2	12.9	2.2	3.1
Beets, sugar	13.5	1.3	10.0	11.3	2.9	0.8	3.7
Blood, dried	91.5	70.9	5.6	76.5	135.0	13.5	7.7
Buckwheat	86.6	8.1	53.6	61.7	17.3	6.9	3.0
Buckwheat bran	91.8	5.9	38.5	44.4	20.2	4.2	12.7
Buckwheat flour	85.4	5.9	65.7	71.6	11.0	6.8	3.4
Buckwheat hulls	86.8	1.2	29.7	30.9	7.3	4.3	14.7
Buckwheat middlings	87.2	22.7	51.2	73.9	42.7	12.3	11.4
Corn, dent	89.4	7.8	76.5	84.3	16.5	7.1	5.7
Corn flint	88.7	8.0	75.9	83.9	16.8	7.1	5.7
Corn, sweet	91.2	8.8	79.5	88.3	18.6	7.1	5.7
Corn ensilage	26.4	1.4	15.7	17.1	4.3	1.1	3.7
Corn fodder, green	20.7	1.0	12.8	13.8	2.9	1.1	3.9
Cornmeal (all)	85.0	6.7	72.2	78.9	14.7	6.3	4.7
Corn stalks with ears	57.8	2.5	37.3	39.8	7.2	5.4	8.9
Corn stover, no ears	59.5	1.4	32.7	34.1	6.1	3.8	10.9
Corn and cob meal	84.9	4.4	66.5	70.9	13.6	5.7	4.7
Corn gluten meal	90.5	29.7	56.2	85.9	54.8	3.3	0.5
Cornhearts, hominy feed	90.4	6.8	77.2	84.0	16.8	9.8	4.9
Canada field peas	85.0	19.7	50.2	69.9	37.9	8.4	10.1
Canada pea meal	89.5	16.8	53.3	70.1	32.3	8.2	9.9
Cotton seed	89.7	12.5	68.9	81.4	29.4	10.5	10.9
Cottonseed meal	93.0	37.6	43.0	80.6	72.5	30.4	15.8
Cottonseed hulls	88.9	0.3	37.0	37.3	6.7	4.3	10.4
Clover hay, red	84.7	7.1	41.8	48.9	19.7	5.5	18.7
Clover hay, alsike	90.3	8.4	42.2	50.6	20.5	5.0	13.9
Clover hay, crimson	90.4	10.5	37.6	48.1	24.3	4.0	13.1
Clover green (red)	29.2	2.9	16.4	19.3	7.0	1.5	4.8
Clover hay, sweet	92.1	11.9	37.8	49.7	28.8	5.6	18.3
Cowpeas, green plants	16.4	1.8	9.2	11.0	3.8	1.3	4.6
Cowpea hay	89.5	9.2	32.2	41.4	14.3	5.2	14.7
Cowpea seed	85.4	16.8	59.2	76.0	32.8	10.1	12.0
Dwarf Essex rape, green	14.3	2.0	8.7	10.7	3.5	1.2	3.5
Flaxseed	90.8	20.6	82.4	....	36.2	13.9	10.3
Kafir (or Milo)	90.1	5.2	47.5	52.7	17.9	....	....
Ky. bluegrass, green	34.9	2.8	21.5	24.3	6.6	2.5	7.0
Ky. bluegrass, hay	86.0	4.4	41.8	46.2	12.5	4.0	15.7
Linseed meal (old pro.)	90.2	30.2	47.5	77.7	54.2	16.6	13.7
Linseed meal (new pro.)	91.0	31.5	41.1	72.6	60.0	17.4	13.4
Meat and bonemeal	94.0	36.7	29.4	66.1	63.2	146.8	....
Meat meal	89.3	66.2	29.2	95.4	114.0	81.1	....
Milk, skim	9.4	2.9	6.1	9.0	5.0	2.1	2.0
Buttermilk	9.9	3.8	6.2	10.0	6.4	1 7	1.6

Digestible Nutrients and Fertilizing Values of Feeds—Continued

Name of feed	Dry matter in 100 lbs.	Digestible parts in 100 lbs.			Fertility in 1000 pounds		
		Protein	Carbo-hydrates (+fat ×2.25)	Total Nutrients	Nitrogen (N)	Phosphoric acid (P_2O_5)	Potash (K_2O)
Whey	6.2	0.6	5.5	6.1	1.0	1.1	2.0
Milk, whole	12.8	3.4	13.1	16.5	5.8	1.9	1.7
Mangels	9.1	1.0	5.9	6.9	2.2	0.9	3.8
Millet seed	87.9	7.1	54.1	61.2	17.4	6.5	3.3
Mixed grasses, green	20.0	2.5	11.2	13.7	5.6	2.6	7.4
Mixed grasses, hay	84.7	4.2	44.9	49.1	11.9	2.7	15.5
Oats	89.6	10.7	58.7	69.4	18.2	7.8	4.8
Oat hay	86.0	4.7	40.5	45.2	14.2	6.7	25.4
Oat hulls	92.6	1.3	39.9	41.2	5.3	1.6	4.9
Oat meal	92.1	11.9	80.2	92.1	23.5	....	....
Oat middlings	91.2	13.1	69.3	82.4	25.9	22.5	15.3
Oat and pea hay	89.5	7.6	44.9	52.5	16.5	6.1	18.1
Oat straw	90.8	1.3	41.3	42.6	5.8	3.0	17.7
Orchard grass, green	27.0	1.2	14.5	15.7	4.2	1.6	7.6
Orchard grass, hay	90.1	4.9	45.6	50.5	12.9	3.7	16.9
Peanuts (hulls on)	94.0	23.2	90.9	....	43.6	9.0	10.0
Peanut meal (or cake)	89.3	42.8	36.6	79.4	76.2	20.0	15.0
Peanut vine hay	92.4	6.7	49.0	55.7	17.1	3.2	11.6
Rice	87.6	6.4	80.1	86.5	11.8	1.8	0.9
Rice bran	90.3	7.6	54.2	61.8	19.0	2.9	2.4
Rice hulls	91.2	0.3	20.1	20.4	5.1	1.7	1.4
Rice meal	89.8	7.4	75.1	82.5	19.2	....	....
Rice polish	89.2	7.9	70.5	78.2	19.0	26.7	7.1
Rye	91.3	9.5	72.1	81.6	18.1	8.6	5.8
Rye bran	88.4	11.2	50.9	62.1	23.3	22.8	14.0
Rye middlings	88.2	11.0	58.8	69.8	22.9	12.3	9.6
Rye straw	92.9	0.7	40.5	41.2	5.0	2.5	8.6
Soybean hay	88.2	10.6	43.6	54.2	23.8	5.2	14.7
Soybean seed	88.3	29.1	56.2	85.3	53.6	10.4	12.6
Tankage	93.0	50.1	26.1	76.2	86.2	139.0	3.0
Timothy, green	38.4	1.5	21.2	22.7	5.0	2.6	7.6
Timothy, hay	86.8	2.8	45.3	48.1	9.4	3.3	14.2
Velvet bean, vine cured	90.0	9.6	55.7	65.3	22.4	....	....
Vetch, hairy, hay	88.7	11.9	44.3	56.2	27.2	9.7	24.4
Wheat	89.5	8.8	70.8	79.6	19.0	5.5	8.7
Wheat bran (winter)	88.5	12.1	43.4	55.5	25.1	26.9	15.2
Wheat—red dog flour	90.1	16.2	64.7	80.9	29.4	....	....
Wheat middlings	88.8	13.0	55.8	58.8	27.0	26.3	15.3
Wheat straw	90.4	0.8	44.2	45.0	5.0	2.2	6.3
Wheat screenings	88.4	9.6	52.5	62.1	20.0	11.7	8.4

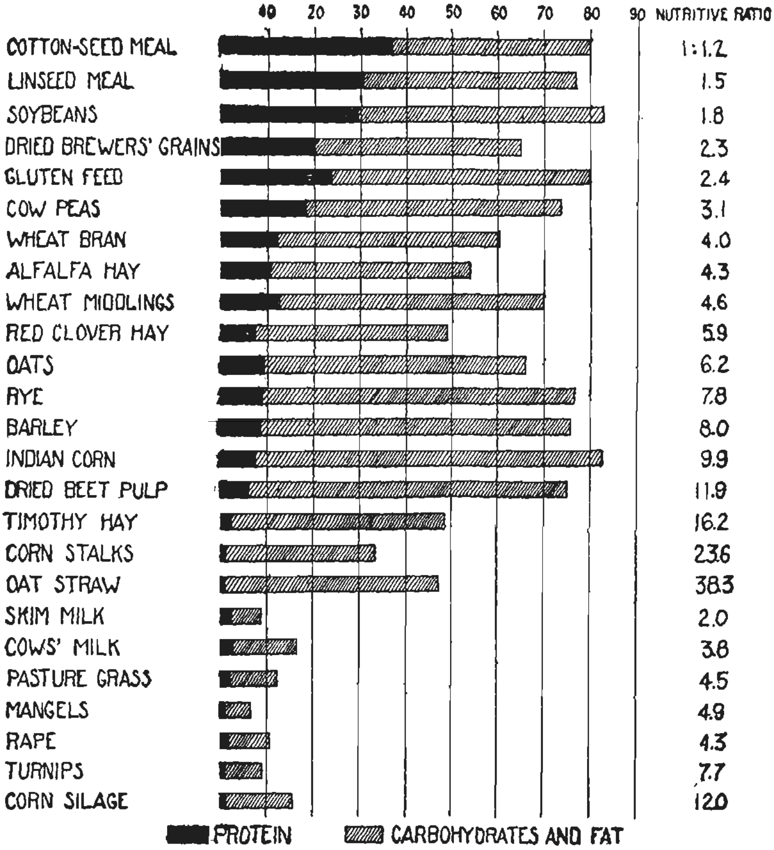


FIG. 323.—Digestible components in common feeds (in per cent). The nutritive ratio, given at the right, is the ratio between the protein (1) and the carbohydrates and fat.

Fertility in Fresh Barnyard Manures, Pounds per 1,000

BARNYARD MANURES	Nitrogen N	Phosphoric Acid, P_2O_5	Potash, K_2O	VALUE PER YEAR 1000 LBS. LIVE WEIGHT	VALUE PER TON OF MANURE[1]
Cow manure	3.4	1.6	4.0	$39.00	$1.91
Horse manure	5.8	2.8	5.3	42.00	3.13
Sheep manure	8.3	2.3	6.7	46.00	4.20
Hog manure	4.5	1.9	6.0	80.00	2.56
Hen droppings	16.3	15.4	8.5		9.12
Mixed stable manure	5.0	2.6	6.3		2.88

[1] Considering nitrogen at 20 cents, phosphoric acid at 6 cents, and potash at 4½ cents per pound.

Average Weights of Concentrated Feeding Stuffs

Feeding stuff.	One quart weighs, pounds.	One pound measures, quarts.
Alfalfa meal	.6	1.7
Barley meal	1.1	.9
Barley, whole	1.5	.7
Beet pulp, dried	.6	1.8
Brewers' grains, dried	.6	1.7
Buckwheat bran	.6	1.7
Buckwheat middlings	.9	1.1
Cocoanut meal	1.5	.7
Corn-and-cob meal	1.4	.7
Corn and oat feed	.7	1.4
Corn bran	.5	2.0
Corn meal	1.5	.7
Corn, whole	1.7	.6
Cotton seed	1.0	1.0
Cotton-seed hulls	.3	3.3
Cotton-seed meal	1.5	.7
Distillers' grains, dried	.6	1.7
Germ oil meal	1.4	.7
Gluten feed	1.3	.8
Gluten meal	1.7	.6
Hominy meal	1.1	.9
Kafir meal	1.6	.6
Linseed meal (new-process)	.9	1.1
Linseed meal (old-process)	1.1	.9
Malt sprouts	.6	1.7
Mixed mill feed (bran and middlings)	.6	1.7
Molasses	3.0	.3
Molasses beet pulp	8	1.3
Oat feed	.8	1.3
Oat middlings	1.5	.7
Oats, whole	1.0	1.0
Rice bran	.8	1.3
Rice polish	1.2	.8
Rye bran	.6	1.7
Rye feed (rye bran and rye middlings)	1.3	.8
Rye meal	1.5	.7
Rye, whole	1.7	.6
Wheat bran	.5	2.0
Wheat feed, mixed	.6	1.7
Wheat, ground	1.7	.6
Wheat middlings (flour)	1 2	.8
Wheat middlings (standard)	.8	1.3
Wheat, whole	1.9	.5
Wheat screenings	1.0	1.0

Description of Common Weeds.

Common name, botanical name, and duration of life.	Color, size, and arrangement of flowers.	Method of seed distribution; vegetative propagation of the perennials.	Place of growth and products injured.
Bindweed, field bindweed	White or pink; 1 inch; solitary.	Grain and flax seeds; creeping roots.	Rich moist soils; grain and hoed crops.
Bull nettle, horse nettle (*Solanum carolinense*), P.	Purple; 1 inch; solitary.	Plants rolled by wind; running roots.	Everywhere; grain and hoed crops, pastures.
Chess, cheat (*Bromus secalinus*), A.	Green; spikelets in panicles.	Grain seed, especially wheat.	Everywhere; grain fields.
Chickweed, common chickweed (*Alsine media*), A.	White; ¼ inch; cymes.	In crop seeds; has a long seeding period.	Meadows, lawns; winter crops.
Cocklebur, clotbur (*Xanthium americanum*), A.	Green; ¼ inch; head.	Carried by animals.	Cultivated fields and waste places; hoed crops and wool.
Crab-grass (*Syntherisma sanguinale*), A.	Green; spikes....	Clover and grass seed, hay, animals.	Cultivated fields, gardens, lawns; hoed crops.
Daisy, oxeye daisy (*Chrysanthemum leucanthemum*), P.	White with yellow center; 1 inch; heads.	Clover seed, hay; woody, rather short rootstocks, but largely by seed.	Pastures, meadows, roadsides; hay pasturage.
Dandelion (*Taraxacum officinale*), P.	Yellow; 1¼ inch; head.	Wind; taproot, which spreads but little.	Lawns, meadows, waste places; hay and lawns.
Dock, yellow dock, sour dock (*Rumex crispus*), P.	Green; ¼ inch; panicle	Hay and straw, clover and grass seed; taproot, which spreads but little.	Hay, small grain, and hoed crops.
Fleabane, horseweed (*Erigeron canadensis*), A.	White; ¼ inch; heads in cymes.	Hay, grass and clover seeds.	Meadows, pastures and grain fields.
Foxtail, yellow foxtail, pigeon grass (*Chætochoa glauca*), A.	Green; spikes....	Animals, hay, grain, and grass seeds.	Land cultivated in early part of season; young grass and clover seedlings.
Lamb's-quarters, pigweed (*Chenopodium album*), A.	Green; very small; panicle.	Grain and grass seed.	Grain fields and hoed crops.
Lettuce, prickly lettuce (*Lactuca virosa*), A.	Yellow; ¼ inch; heads in panicles.	Wind............	Everywhere; all crops.
Pigweed, redroot, careless weed (*Amaranthus retroflexus*), A.	Green; quite small; spikes in panicles.	In grain and grass seeds; plants blown by wind.	Plowed land; hoed crops.
Plantain, buckthorn, rib-grass (*Plantago lanceolata*), P.	White; $\frac{1}{16}$ inch; spike.	Hay, clover and grass seed; spreads but slowly from a crown.	Everywhere; meadows, pastures, and lawns.
Poison ivy, poison oak (*Rhus toxicodendron*), P.	Greenish white; ⅛ inch; panicles.	Does not spread fast by seeds; running root-stocks.	Moist rich land, along fences; poisonous by contact.
Purslane, pusley (*Portulaca oleracea*), A.	Yellow; ¼ inch; solitary.	Implements; has a long seeding period.	Rich cultivated land, gardens; hoed crops.
Ragweed, smaller ragweed (*Ambrosia elatior*), A.	Yellow; ¼ inch; small heads on spikes.	Wind carrying matured plants; in grain and red-clover seeds.	Everywhere; grain stubble; hoed crops, grass seeding.
Sorrel, sheep sorrel, horse sorrel (*Rumex acetosella*), P.	Red; ⅛ inch; panicles.	In clover seed; creeping roots.	Meadows and pastures.

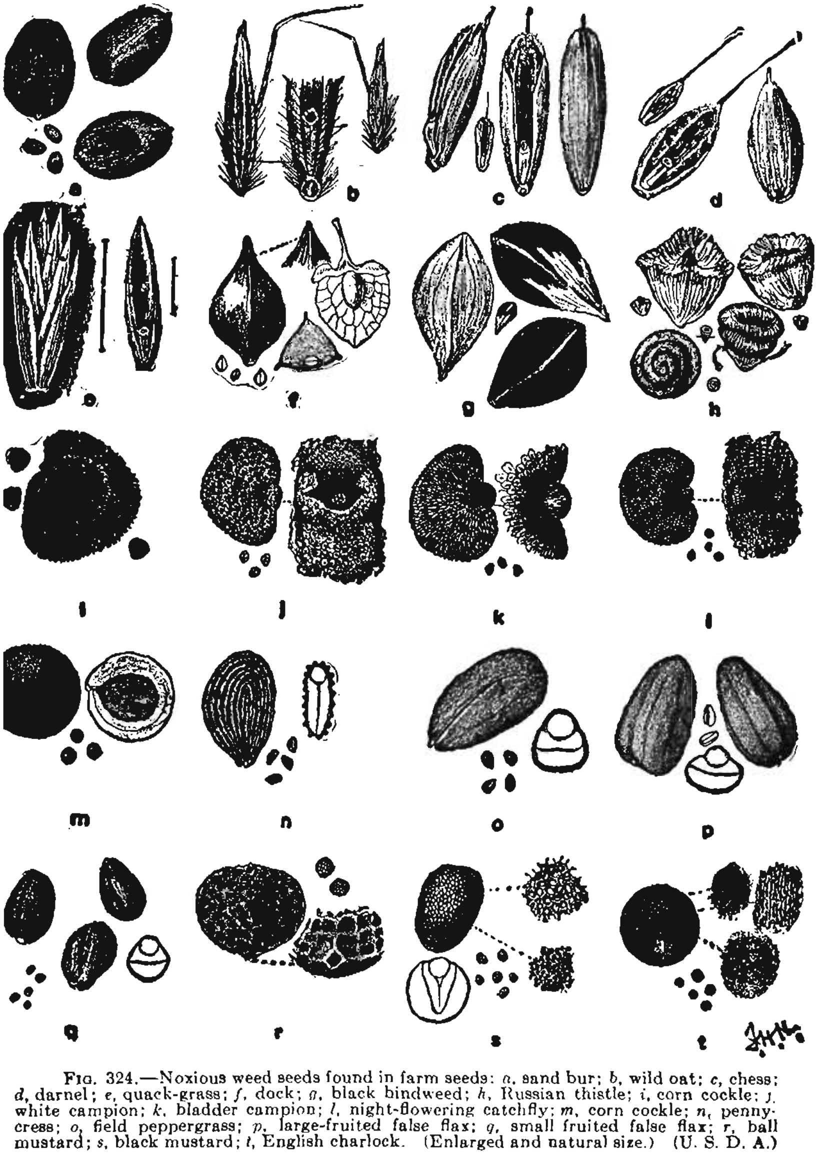


FIG. 324.—Noxious weed seeds found in farm seeds: *a*, sand bur; *b*, wild oat; *c*, chess; *d*, darnel; *e*, quack-grass; *f*, dock; *g*, black bindweed; *h*, Russian thistle; *i*, corn cockle; *j*, white campion; *k*, bladder campion; *l*, night-flowering catchfly; *m*, corn cockle; *n*, penny-cress; *o*, field peppergrass; *p*, large-fruited false flax; *q*, small fruited false flax; *r*, ball mustard; *s*, black mustard; *t*, English charlock. (Enlarged and natural size.) (U. S. D. A.)

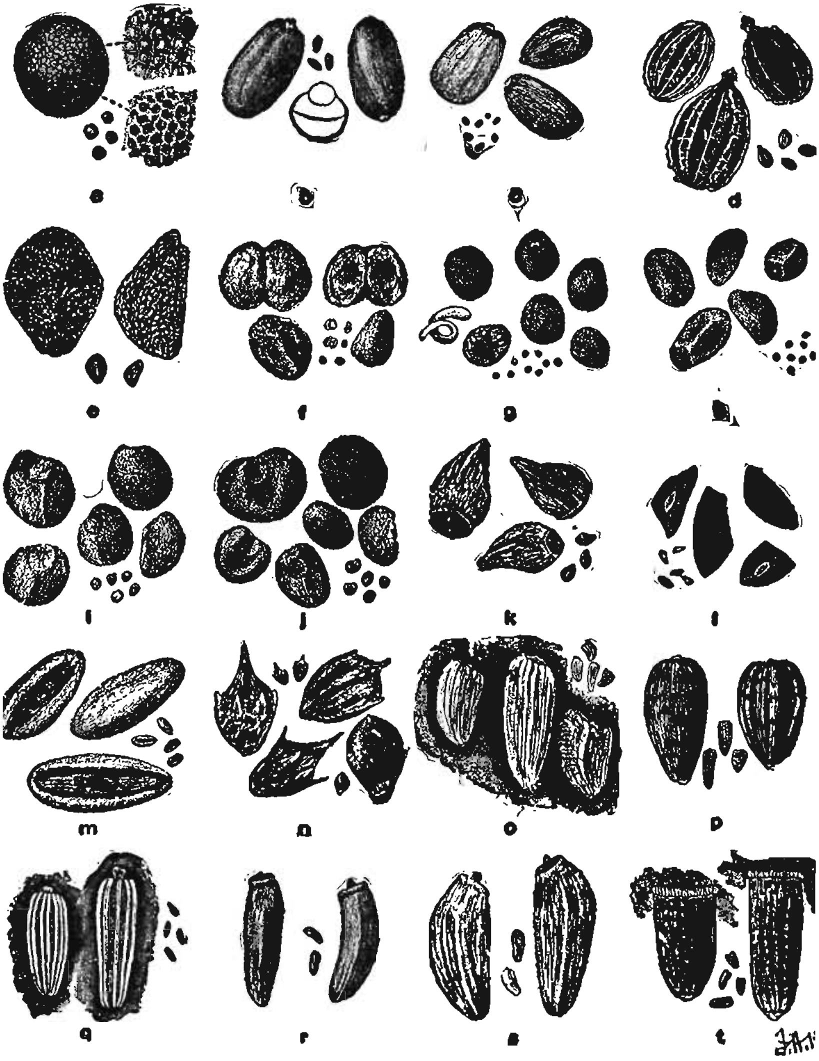


Fig. 325.—Noxious weed seeds found in farm seeds; *a*, Indian mustard; *b*, hare's-ear mustard; *c*, tumbling mustard; *d*, wild carrot; *e*, field bindwood; *f*, flax dodder; *g*, clover dodder; *h*, small-seeded alfalfa dodder; *i*, field dodder; *j*, large-seeded alfalfa dodder; *k*, corn gromwell; *l*, rat-tail plantain; *m*, buckhorn; *n*, ragweed; *o*, gum weed; *p*, wild sunflower; *q*, oxeye daisy; *r*, Canada thistle; *s*, bull thistle; *t*, wild chicory. (Enlarged and natural size.) (U. S. D. A.)

INDEX

A

Aberdeen-angus, 375, 376
Accounting, farm, 18
Account keeping, 18
Accounts, farm, 19
  kinds, 18
  reasons for, 18
Age for planting trees, 319
  of horses, 396
Agricultural map, 34
Alfalfa as pasture, 156
  charts, 159
  cultivation, 154
  curing, 155
  debates, 159
  enemies, 154
  enterprise, 149
  exercises, 159
  fertilizing, 154
  for feed, 156
  hay, 153, 156
  history, 159
  investigations, 159
  irrigation, 154
  liming, 153
  meal, 156
  nodules, 151
  pictures, 159
  problems, 159
  questions, 159
  regions, 149, 150
  rotations, 157
  seed, 150
  seeding, 152
  soils, 149
  survey, 159
  trips, 159
  value of, 156, 157
  varieties, 149, 150
Alsike clover, 163
Amendments, soil, 53
American saddle horse, 390, 392
  trotter, 391
Analysis, job, iv, 4, 20
Angora goats, 403
Angus cattle, 375, 376
Animal power, 444
Annual legumes, 169–176
Aphis, life history, 297, 298
Apiary, location, 435
Apple borers, 241
  diseases, 244, 246
  spraying, 255
  trees, growing, 230
Apricot trees, low headed, 238
Artichokes, globe, 294
Asparagus, 293
Ayrshires, 349

B

Baby beef, 381
Bacon breeds, 328
  type, 326
Bacteria, 51–54
  in milk, 366
Balanced ration, 357
Bales, sizes of 145
Banked trees, 239
Barberry, rust on, 96
Bare fallow, 50, 51
Barley fertilizers, 106
  grades, 109
  harvesting, 108
  history and uses, 109
  projects, 106–109
  regions, 106
  seed, 107
  soils, 106, 107
  sowing, 107
  storage, 109
  thrashing, 108, 109
  types, 107, 108
Barn, dairy, 360
  sheep, 405
  tobacco, 225
Barnyard manure, 46, 47, 48
  millet, 129
Barrow, champion, 327
Baumé hydrometer, 465
Bean map, 173
Beans, 294, 295
  velvet, 175
Bee colony, 434
  debates, 441
  enterprise, 433
  equiptment, 454
  investigations, 443
Beekeeping experience, 437
  kinds of, 435
  starting, 434

Beekeeper's tools, 436
Bee methods, 442
pastures, 437
projects, 434, 442
questions, 443
races, 434
survey, 441
trips, 442
Bees, kinds of, 434
wintering, 442
Beef, baby, 381
breed to use, 378
breeds, 373–376
bull, 379
cattle, age of, 380, 381
charts, 383
conditions, 376
cows, 379
cuts, 383
debates, 384
developing, 377
enterprise, 373
feed lot, 377–379
finishing, 377
histories, 382
investigations, 384
judging points, 383
lot council, 381
marketing, 382
pictures, 384
problems, 383
production, types, 376
questions, 384
rations, 382
shelter, 378
surveys, 383
trips, 384
Beets, garden, 289
Belgian horses, 386, 388
Berkshire, 326
Bermuda grass, 138
Binding soybeans, 171
Blackberry enemies, 265
Blackberry enemies, 263
freezing, 265
intercropping, 264
locations, 263
marketing, 265
picking, 265
planting, 266
projects, 263
propagation, 263
Blackberry pruning, 264
varieties, 263
Black medic, 157
Black-rot disease, 194
Blanching celery, 290
Blight, potato, 186
Blotch (Frog-eye), 244
Blue-grass, Canada, 138
Kentucky, 137, 138
Boll-weevil, 211, 212, 214
Boll-worm, 212
Bordeaux mixture, 467
platform, 300
Border, flower, 308, 309
Borecole, 291
Borers, 242, 243
Bottling milk, 364
Boys' exhibits, 315
Brahmas, 415
Breed beef to use, 378
Breeding cows, 355
herd, 380
potato, 188
sheep for, 404
Breeds, beef, 373–376
dairy, 345–349
draft, 385–388
to choose, 328
Brooder house, 418
making, 456
Brooders, 418
Brooding, natural, 416
Brome grass, 140
Broom-corn, 120
millet, 129
Brown-rot, stone fruits, 244, 246
Buckeyes, 414
Buckwheat, harvesting, 113
map, 121
projects, 113
uses, 113
Budding trees, 230, 232
Burr-clover, 158
Business of farming, 6–21
Butchering swine, 342
Butter, dairy, 367
factory, 367
making, 366, 367
marketing, 368
vs. milk, 370
Buying cattle, 379

C

Cabbage, 288
Calcium, 27, 28, 168
Calculations, see each chapter
Calculating rations, 357
Calf feeding, 359
Calves, dehorning, 359
Calving time, 354
Campaigns, spraying, 245
Canada field peas, 172

INDEX

Canker worms, 241
Cantaloupes, 296, 297
Capillary moisture, 23
  rise, 51
Capital *vs.* labor income, 11
Caponizing, 430
Carburetor, 445
Carpet grass, 141
Carrots, 290
Castrating lambs, 407
  pigs, 336
Catalpa products, 321
Cattle buying, 379
  diseases, 361
  dual-purpose, 380
  tuberculosis, 360
Cauliflower, 287
Cedar apples (rust), 246
Celery, 289, 290
Cereal hay, 96
Chard, 291
Chart, septic tank, 314
Charts, alfalfa, 159
  beef, 383
  close of chapters
  clover, 168
  corn, 82
  cotton, 217
  dairy, 370
  farm practices, 56b, 118b
  grain, 116
  grass, 146
  horse, 395
  legume, 176
  potato, 189
  poultry, 429
  power, 450
  sheep, 409
  shop, 462
  small fruit, 272
  sorghum, 130
  sugar beet, 203
  sweet potato, 197
  swine, 342
  woodland, 323
Cheese making, 368
Cherries, diseases, 246
Chester White, 327
Chick feeding, 419
Cholera, hog, 225
Choosing a farm, 8
Chopping cotton, 211
Churning, steps, 367
Citrus scale, 243
Clarified milk, 365
Classes of garden crops, 276
Class-room discussions, 3
Clean culture *vs.* sod, 237, 238
Clean milk, 363, 364
Cleft grafting, 233
Clipping bee wings, 440
Cloth beds, 283
Clover, Alsike, 163
  burr, 158
  charts, 168
  crimson, 164, 165
  debates, 168
  enemies, 162
  exercise, 168
  hay making, 162
  histories, 167
  hulling, 164
  investigations, 168
  Japan, 174
  liming, 163
  list, 167
  mammoth, 163
  problems, 167
  projects, 161–168
  questions, 168
  red, 161
  rotations, 161
  seeding, 161
  soils, 161
  survey, 167
  sweet, 158
  trips, 168
  white, 166
Clydesdales, 387, 388
Coach horses, 389
Cochins, 415
Codling moth, 241
Coldframes, 279, 280
Collards, 292
Colonies, dividing, 440
  uniting, 438
  weak, 438
Community gathering, 166
  work, 315, 316
Companion crops for corn, 72
Compost, garden, 282
Concentrates, 357
Condensed milk, 369
Cool-season crops, 285–289
Coop, hen-and-chicks, 415
Coöperation charts, 410b, 433
Corn books and bulletins, 83
  charts, 82
  debates, 82
  diseases, 77
  enterprises, 57
  enemies, 77
  fodder, 78
  harrowing, 72

Corn harvesting, 77, 78
hogging-off, 340
insects, 75, 76
investigations, 82, 83
judging, 63, 64
market grades, 81
moisture, 57
origin of, 81
pictures, 82
planting, 70, 71
pop, 295
problems, 82
projects, 81
questions, 82, 83
ratio to pork, 343
regions, 57, 58
score poiuts, 64, 65
seed bed, 70
plot, 74
selection, 59, 60, 64
silage, 79
soils, 57, 59
storage, 60, 62, 79, 80
study, winter, 67
survey, 81, 82
sweet, 61, 63, 295
table, 295
testing, 66, 67
tillage, 73–75
trips, 82
types, 61, 62
varieties, 63
yields, 79, 80
Cost of producing vegetables, 9
Cotswolds, 402, 403
Cotton boll-weevil, 211–213
boll-worms, 212
Cotton charts, 217
chopping, 211
combed, 206
Cotton cultivation, 211, 213
debates, 217
diseases, 213
early crop, 212
enterprise, 205
fertilizer, 207
ginning, 214, 215
grades, 207, 215, 216
harvesting, 213
history, 216
investigation, 217
plant, typical, 210
planting, 209, 211
problems, 217
projects, 216, 217
questions, 217
region map, 205
Cotton samples, 217
seed and lint compared, 209
seed, buying, 209
selection, 209
soils, 206
staple, 206
survey, 216
trips, 217
types, 205
varieties, 208
Cover crops, 48, 59
Cowpeas, 169
in corn, 72
with millet, 130
Cow's udder, 356
Crate fattening, 427, 428
Cream separators, 366
Crimson clover, 164, 165
seed, 166
Crop equipment, 456
exhibit, 315
Crops, hot-and-cold, 284, 294
pasture, 330
warm-season, 294–300
Cross pollination, 31
Crown gall, raspberry, 264, 265
Cucumbers, 297, 299
Culling ears, 64
poultry, 425–427
sows, 336
Culti-packer, 42
Cultivating alfalfa, 154
cotton, 211, 213
potatoes, 182, 183
Cultivators, 213
Culture, orchard, 237, 240
Curculio, plum, 242
Curing clover, 162, 163
hay, 136
tobacco, 224
Currant cherry, 267
enemies, 267
locations, 266
picking, 267
planting, 266
projects, 266
propagation, 266
pruning, 267
Cutting potatoes, 180
sorghum, 124
Cuttings, hardwood, 270

D

Dairy barn, 360
breeds, 345–349
breeds, minor, 349
butter, 367

Dairy by-products, 369
charts, 370
debates, 371
enterprise, 345
equipment, 454
feeding, 355–359
herd, 345–364
herd, starting, 350
hints, 359
investigations, 371
judging, 371
judging points, 350–353
management, 354
problems, 370
products, 364–370
projects, 370, 371
questions, 371
records, 361
survey, 370
Debates, alfalfa, 159
bee, 441
beef, 384
clover, 168
corn, 83
cotton, 217
dairy, 371
garden, 301
grain, 116
grass, 146
horse, 395
legumes, 175
orchard, 254
potato, 189
poultry, 430
power, 450
sheep, 409
small fruit, 272
sorghum, 131
sugar beet, 203
sweet potato, 197
woodland, 323
Debt plan, 8
Deborning calves, 359
Demonstrations, potato, 189
Devon cattle, 376
Diggers, potato, 185, 187
Dirty cow, 365
Discussions, class-room, 3
Diseases, cattle, 361
Diseases of corn, 77
cotton, 213
orchard, 244
potatoes, 184
poultry, 424
sweet potatoes, 194
tobacco, 223
Disk harrow, 41
Docking lambs, 407
Dogs *vs.* sheep, 399
Dominiques, 414
Dorset sheep, 402
Draft breeds, 385–388
Draft type, 387
Drag, plank, 281
Drainage, 41, 42
Drainage, road, 311
Dressing poultry, 431
Dry farming, 51
Dry farming, wheat, 93
Dry mashes, 422
Dual-purpose cattle, 380
Durhams, 373, 374
Duroc-Jersey, 326
Durra, 119, 120
Dusting machine, 249
Dust mulch, 50, 51

E

Economy in equipment, 10
of labor, 14, 15
Egg, breed, shape, 413
Egg-plant, 300, 301
Egg testing, 419
Eggs, hatching, 417
market, 428
Electric power, 445
Endive, 292
Enemies, alfalfa, 152
corn, 77
freedom from, 29
grape, 270
rice, 112
Engine, gas, 445, 446
installing, 447
Engine sizes, 447
troubles, 446, 447
uses, 448
English walnuts, budding, 232
Enterprises, farming, Chapter IX to XXVII
Equipment, economy in, 10
farm, 453–458
making, 454
Ergot disease, 110
Eveners, 3-horse, 456
Exercise for sows, 335
Exercises, 397
alfalfa, 159
close of chapters
clover, 168
garden, 302
grain, 117
improvement, 317
legume, 175

Exercises, orchard, 254
potato, 189
poultry, 430
power, 450
sheep, 409
small fruit, 272
sweet potato, 198
swine, 342
tobacco, 256
woodland, 323
Exhibit, 315
Extracting honey, 437
sugar, 202

F

Fair booth, 315
Fall plowing, 25
Farm accounting, 18
choosing, 8
Farmer salesman, 16
Farming as a calling, 6
starting, 6
system, 16
types of, 9
Farm management, 17, 19, 20
books, 21
charts, 20
debates, 20
exercises, 20
investigations, 20
problems, 19
projects, 20
questions, 20, 21
surveys, 19
trips, 20
Farm losses, 16
Farm planning, 17
power, 444–451
Farm profits, 13
shop plan, 452
shop work, 452–463
sizes of, 9
tractors, 449
wastes, 14
Farmstead plans, 304
Farrowing time, 333, 334
Fattening, crate, 427, 428
pork, 339
Feeders, producing, 377, 378
Feeding alfalfa, 152, 156
beef, 377–379
bees, 438
by weight, 358
calves, 359
chicks, 419
dairy, 355–359
horses, 395
Feeding lambs, 407
laying hens, 421
practice, 357
sheep, 404
tables, 468, 469
Feed-lot council, 381
Feed lots, 377–379
value of grasses, 144, 146
Feeds, composition, 468, 470
manure in, 47
poultry, 421
swine, 332, 333
weights of, 471
Feet trimming, 394
Fertility in feeds, 469, 470
Fertilizer value of grasses, 144, 146
Fertilizers, 44, 45
applying, 178
barley, 106
corn, 69
cotton, 207
garden, 283
potato, 177, 178
sorghum, 123
sweet potato, 191
Fertilizing alfalfa, 154
grapes, 270
orchards, 239
Fescue, meadow, 141
Field bean map, 173
beans, 174
crop equipment, 456
peas, 172
selection of seeds, 60
trips, alfalfa, 159
bee, 442
beef, 384
Field trips, beef, 203
close of chapters,
clover, 168
corn, 82
cotton, 217
dairy, 371
garden, 301
grain, 117
grass, 146
horse, 397
improvement, 317
legume, 175
orchard, 253
potato, 189
poultry, 430
power, 429
sheep, 409
small fruit, 271
sorghum, 131
sweet potato, 197

Field trips, tobacco. 226
woodland. 323
Filled milk, 370
Fillers, orchard, 234
Finishing age, beef, 380, 381
Flax fiber, 115
grain, 116
hackles, 115
harvesting, 115
projects, 114
region map, 220
regions, 114
seeding, 114
soils, 114
uses, 116
Floral table. 307
Flower border, 308, 309
parts, 37
planting, 307
Flowers, 30
annual, 308
early, 308
late, 308
perennial, 306
Food, from air, 26
from soil, 27
in plants, 32, 35
Forest benefits, 322
methods, 323
Forest planting, 320–324
Forestry principles, 322, 323
Formaldehyde, 467
Free water, 23
Frog-eye *fungus*, 244
Frost injury, 238, 241
Fruit equipment, 454
grades, 251, 252
harvesting, 250
judging, 254
packing, 250–252
selling, 251
spurs, apple, 242
Fungicides, 465–467

G

Garden charts, 301
compost, 282
crops, classes of, 276
crops, hot-and-cold, 289–294
debates, 301
enterprises, 275
equipment, 276, 454
exercises, 301
fertilizer, 283
investigations, 302
locations, 275
marker, 283
Garden planning, 278, 279
problems, 301
projects, 275, 301
questions, 302
record, 277
seeds, 279
soil, preparing, 282
soils, 275
surveys, 301
table, 277
tools, 276
trips, 301
Gas engines, 445, 446
General purpose poultry, 413
Germination exercises, 36
Gestation period, swine, 337
Gilts, number to buy, 330
selecting, 329, 339
Ginning cotton, 213, 214
Glazing, 457
Globe artichokes, 294
Goats, Angora, 403
milk, 350
Gooseberry, enemies, 267
locations, 266
picking, 267
planting, 266
projects, 266
propagation, 266
pruning, 267
Grades, barley, 109
corn, 81
cotton, 207, 215
Grades, fruit, 251, 252
market, wheat, 100, 101
oats, 105
Grading potatoes, 185
tobacco, 224
Grafting trees, 232, 233
Grafts, roots, 231
Grain books and bulletins, 118
charts, 116
debates, 116
drilling, 90, 91
enterprises, 85
exercises, 117
harvesting, 97
investigations, 118
letters, 117
practicums ,116
projects, 116–118
questions, 118
samples, 117
sorghums, 119, 120
survey, 116
trips, 117

Grape cultivation, 270
  cuttings, 270
  enemies, 270
  fertilizing, 270
  locations, 268
  packing, 273
  picking, 271
  planting, 269
  projects, 268
  propagation, 269
  pruning, 270, 271
  soils, 268
  spraying, 272
  trellising, 269, 271
  varieties, 268
Grapes, Niagara, 269
  vinifera, 268
Grasses, Chapter on, 133
  books and bulletins, 146
  charts, 146
  compared, 146
  debates, 147
  for hay, 134
  for pasture, 133, 134
  investigations, 146
  mixtures, 134
  problems, 146
  projects, 147
  questions, 148
  regions map, 135
  seed, harvesting, 143
    weights, 144
  surveys, 146
  trips, 147
  wild prairie, 135
Green manure, 28, 48, 49, 165
Growth, conditions for, 22
Guernseys, 347
Gumbo, 296

H

Halter, rope, 462
Hambletonians, 395
Hampshire, sheep, 402
  swine, 327
Hanover, 292
Harness repair, 458
Harrow, Acme, 25
  disk, 41
  spike tooth, 50
Harrowing corn, 72
  grain, 93, 104
Harvesting alfalfa seed, 155
  barley, 108
  buckwheat, 113
  corn, 77–79
  cotton, 213
Harvesting flax, 115
  fruit, 250
  grain, 97
  grass seed, 143
  oats, 104
  potatoes, 184, 185
  rice, 111
  rye, 110
  sugar beets, 201
    cane, 129
  sweet potatoes, 195
  tobacco, 224
Hatching eggs, 417
Hay bales, sizes, 145
Hays, calcium in, 168
Hay, cereal, 96
  classes, 145
  grasses for, 134, 135
  loader, 157
  making, 155, 162
  making machinery, 144
  selling, 145
Hays, nitrogen in, 168
  rake, 156
  stackers, 158
Heading, low *vs.* high, 237, 240
Healing in strawberries, 259
  trees, 235
Heater, orchard, 238
Hedge plants, 306
Hemp, region map, 220
Herd, breeding, 380
Herefords, 373, 375
High heading *vs.* low, 237, 240
Hilling-up potatoes, 182
Hill selection, potatoes, 180
Hives, inspecting, 439
  locating, 435
  moving, 435
  parts, 436
Hog, see also Swine, 325–342
  parts, 329
Hogging-off corn, 78, 340
Holding milk, 365
Holstein, champion, 350
Holstein-Fresians, 347
  type, 348
Home equipment, 456, 457, 459
  garden plans, 278
  mixing of fertilizers, 45, 69, 70
Honey extraction, 437
  kinds, 441
Hoofs, trimming, 394
Horse, age by teeth, 396
  charts, 395
  coach, 389
  debates, 395

Horse, draft type, 387
enterprise, 385
equipment, 454
exercises, 397
feeding, 395
investigations, 398
points of, 397
problems, 395
questions, 398
selection, 385
surveys, 395
trips, 397
Horse's feet, 394
light, 389
Horseradish, 291
Hotbeds, 279, 280
management, 281
planting, 281
plants, 283
Hot-season crops, 289–300
House, A-form, 334
poultry, 420, 421
Housing swine, 333
Hydraulic ram, 447, 448
Hydrometer, 465
syrup, 127
Hygroscopic moisture, 23

I

Ignition, 446
Improvement benefits, 303
books and bulletins, 318
chart, 314
enterprise, 303
exercises, 317
investigations, 317
kinds of, 316
problems, 317
projects, 303–317
questions, 317
rural, 315
school, 316
tillage, 41, 49, 73, 74
trips, 317
Impurities in seed, 33
Incubation, cellar, 418
natural, 415
Incubator, running, 418
Incubators, 417
Inoculation, 51, 52, 53
alfalfa, 151
methods, 151
Insecticides, 465–467
Insects, corn, 75, 76
orchard, 241
potato, 183
sweet potato, 195
Insects, tobacco, 223
wheat, 94–96
Inspecting hives, 439
Intercropping orchard, 239
Inventory, 19
Investigations, management, 17
Investigations, *close of chapters*
Irish potato enterprise, 177
Irish potato fertilizers, 177, 178
regions, 177
soils, 177, 178
Irrigating alfalfa, 154
Irrigation, 42, 43
of potatoes, 183
overhead, 284, 299
pipe, 305
Italian bees, 434

J

Japan clover, 174
Jerseys, 346
Job analysis, iv, 4, 20, see *Chapters IV to XXVII*
Johnson grass, 142
Judging, dairy, 371
fruit, 254
pigs, 339
points, beef, 383
points, dairy, 350–353

K

Kafir, 119–126
Kale, 291
Kentucky bluegrass, 137, 138
Killing poultry, 431
King drag, 313
Kohlrabi, 288
Kowliang, 120

L

Labor, economy of, 14, 15
income, 11, 12
in crops, 10
Lambing time, 406
Lambs, docking and castrating, 407
Langshans, 415
Langwater Dairy Maid, 347
Lard type, 325
Large Yorkshire, 327
Lawns, 309, 310
Layer, signs of, 425–427
Layout, orchard, 235
Leaf section, 27
Leather work, 456, 458
transpiration, 36
uses, 29
Leaves and light, 36

Legume books and bulletins, 176
charts, 175
debates, 175
exercises, 175
investigations, 176
problems, 175
projects, 176
questions, 176
survey, 175
trips, 176
Legumes, annual, 169–177
Leicester sheep, 403
Lemons, budding, 232
Lens, 33
Lespedeza, 174
Lessnessock Dairy Loudoun, 349
Letters, grain, 117
Lettuce, 285
Lice, hog, 335
poultry, 423
Life history, aphis, 297
Light for plants, 36
Light horses, 389
Lima beans, 294, 295
Lime, kinds, 44
Lime-sulphur, 466
test, 466
Liming, 43
clover, 163
for alfalfa, 153
Lincoln sheep, 403
Lint compared to seed, 208
Litter, weaned, 337
Litters, two a year, 337
Livestock and agriculture, 46, 47
in orchards, 248
receipts, 7
Losses, farm, 16
Low heading *vs.* high, 237, 240
Lumber mules, 392

M

Macadam roads, 312
Machine study, 460
Machinery, haymaking, 144
repair, 459
Making equipment, 454
Mammoth red clover, 163
Management, dairy, 345–364
herd, 380
horse, 394
Mangel field, 203
Mangels, 202–204
compared with beets, 202, 203
regions, 202
Manure, 46, 47
green, 48, 49
Manure in feeds, 47
spreader, 46
Manures, 28
compared, 48
Manuring in winter, 68
Map, agricultural regions, 34
alfalfa, 150
barley, 106
buckwheat, 121
corn, 58
cotton, 205
field bean, 173
flax, 220
grain sorghums, 121
hemp, 220
peanut, 173
precipitation, 24
red clover, 160
rice, 220
soils, 39
tobacco, 220
velvet beans, 121
wheat, 85, 86, 87
wild grasses, 135
Mares for mules, 393
Marker, home-made, 283
Market classes of hay, 145
cotton, 207, 215
eggs, 428
grades of barley, 109
of corn, 81
of grain, 100, 101, 105
Marketing alfalfa, 156
beef, 382
butter, 368
charts, 410b, 433
milk, 365
oats, 104
potatoes, 187
poultry products, 429
tobacco, 226
Market types, hogs, 341
Markets, swine, 340
Mashes, poultry, 422
Meadow fescue, 141
Meat breeds, poultry, 413, 414
Mechanics, each chap.
Melons, 296, 297
Memorandum records, 18
Merion sheep, 400
Mice, injury, 248
Milk bacteria, 366
bottling, 364
clarifying, 365
clean, 363, 364
condensed, 369
cow, 354

Milk, filled, 370
goats, 350
holding, 365
marketing, 365
pasteurizing, 365
powder, 370
vs. butter, 370
Milking, 355
Millet and cowpeas, 130
culture, 130
enterprise, 129
projects, 131
types, 129
Milo, 119
Mine mules, 392
Minerals in plants, 36, 37
Mites, poultry, 423
Mixing sprays, 247
Moisture and germination, 36
conservation, 25
for corn, 57
in soil, 23
Morgan horse, 390
Movable house, 334
Mulch, strawberry, 261
Mule mares, 393
enterprise, 385
projects, 385–398
Mules, 392
Muskmelons, 296, 297
Mustard, 286

N

Native plants, 308
Natural brooding, 416
incubation, 415
New Zealand spinach, 286
Niagara grapes, 269
Nicotine sulfate, 184
Nitrogen, 27, 44
in hays, 168
Nodules, alfalfa, 151
legume, 53, 54
Nurse crop for grass, 138
Nut culture, 227
Nutritive ratio, 356, 357

O

Oat harvesting, 104
history, 105
preparing for, 103
projects, 102–105
seed, 103
seeding, 104
soils, 102
types and varieties, 102
Oats, clipped, 105
grades, 105
harrowing, 104
harvesting, 104
marketing, 104, 40a
sprouted, 423
storing, 104
thrashing, 104
uses, 105
Official testing, 363
Okra, 296
Oleomargarine, 369
Onions, 292, 293
Optional studies, *close of each chapter*
Orange trees, banked, 239
rust, blackberry, 265
Oranges, budding, 232
Orchard, by-products, 253
charts, 253
debates, 254
diseases, 244
distances, 234
enterprise, 227
exercises, 254
fertilizing, 239
grass, 139
heaters, 238
insects, 241
intercropping, 239
investigations, 255
layout, 235
low-headed, 238
pictures, 254
plans, 234
planting, 233
problems, 253
projects, 255
questions, 254
regions, 227
sites, 228
soils, 227, 233
surveys, 253
tillage, 238–240
tree, age, 232
trees, 229
trips, 253
varieties, 228
Ornamental planting, 305
Orpingtons, 414
Osmosis, 35
Overrun, 368
Owners *vs.* tenants, 7
Oxygen, need of, 28

P

Packing fruit, 250–252
grapes, 273
house, apple, 251
of soils, 42, 51, 52
tables, 252
Panel, sheep, 406
Parsley, 292
Parsnips, 291
Parts of hog, 329
Pasteurizing milk, 365
Pasturage, dairy, 358
Pasture areas, 331
fence, 321
grasses, 133
mixtures, 134
Pastures, bee, 437
swine, 330, 331
Pasturing alfalfa, 156
grain, 93
Peach borers, 243, 244
diseases, 245, 255
package, 252
spraying, 255
trees, growing, 229
Peanut, harvesting, 173
map, 173
Peanuts, 172–173
Pearl millet, 129
Pear trees, growing, 230
Pears, 227
Peas, Canada, 172
garden, 255
Pecans, budding, 232
Pedigrees, swine, 330
Peppers, 300
Percheron mare, 397
Percherons, 385–387
Permanent agriculture, 46, 47
Phosphoric acid, 44, 45
Phosphorus, 27
Physiology, plant, 22–37
Picking grapes, 271
potatoes, 186
strawberry, 262
Pictures, beef, 384
grain, 116
grass, 146
Pig creep, 334
Pig farrowing, 333, 334
Pig, see also swine, 325–342
Pigs, fall, 341
Pink, boll-worm, 213
Pipe fitting, 459
Plan, garden, 279
Plank drag, 282
Planning a farm, 17
farmsteads, 304
Plantation mules, 392
Plant food, 26–28
growth, conditions, 22
Plant lice, 184, 298, 299
Planter, cotton, 211
potato, 181
Planting board, 236
ornamental, 305
Planting plans, orchard, 234
rules, 284
sugar beets, 200
trees, 233, 236
Plants and seasons, 33
Plow, forms of, 41
Plowing, fall, 25
Plum trees, growing, 229
Plums, 227
Plymouth Rocks, 414
Poisons, 465
compared, 243
Poland-China, 327
Polled Herefords, 376
Shorthorns, 376
Pollination, 30, 31
Ponies, 391
Popcorn, 295
Pork fattening, 340, 343
Potash, 45
Potassium, 27
Potato blight, 186
Potato breeding, 187
charts, 189
cultivation, 182, 183
cutting, 180
debates, 189
diseases, 184
enterprise, 177
exercise, 189
grading, 186
harvesting, 184, 187
history, 188
insects, 183
investigations, 190
irrigation, 183
marketing, 187
planting, 178, 181
projects, 189
questions, 190
ridging, 182
scab, 181, 185
seed, 179
selection, 180
storage, 187, 188
survey, 188, 189
trips, 189

Potato, types of crops, 179
varieties, 179
Poultry articles, 430
breeds, 412, 413
business, 411
charts, 429
coop, 417
culling, 425–427
debates, 430
diseases, 424
dressing, 431
enterprise, 411
equipment, 454
exercises, 430
feeds, 422
house, interior, 420, 421
size, 420
investigations, 430
killing, 431
laying house, 420
meat breeds, 414
mites and lice, 423
problems, 429
projects, 411–430
questions, 430
records, 430
sanitation, 423
skeleton, 425
starting, 411
succulence, 422
survey, 429
trips, 430
type-shape, 413
Power, animal, 444
books and bulletins, 451
charts, 450
debates, 450
electric, 445
exercises, 450
farm, 444–451
investigations, 451
problems, 450
projects, 450
questions, 451
sprayers, 272
surveys, 450
trips, 450
Precipitation map, 24
Preparation for corn, 59
potatoes, 178
rice, 111
Preparing orchard soil, 233
Prices, tobacco, 226
Priming tobacco, 223
Problems, alfalfa, 159
beef, 383
close of chapters,
Problems, clover, 167
corn, 82
cotton, 217
dairy, 370
garden, 301
grass, 146
horse, 395
improvement, 317
legume, 175
orchard, 253
potato, 189
poultry, 429
power, 450
sheep, 409
small fruit, 272
sorghum, 130
sugar beet, 203
sweet potato, 196
swine, 341
woodland, 323
Production records, 361
tobacco, 221
Profits, farm, 13
from improvements, 303
Project equipment, 4
grape, 268
major, 2
method books, 5
methods, 1
minor, 2
profits, 303
records, 3
report, 3
Projects, alfalfa, 149–160
barley, 106–109
bee, 433, 442
beef, 373–384
blackberry, 263
buckwheat, 113
classes of, 1
close of chapters,
clover, 168
corn, 57, 82
cotton, 205, 217
currant, 266
dairy, 345, 364, 371
products, 364
flax, 114
garden, 275, 301
gooseberry, 266
grain, 84–118
grass, 133, 146
group, 1
home, 2
horse and mule, 385–398
improvement, 2, 303, 317
individual, 1

Projects, Irish potato, 177
legume, 175
management, 2
millet, 129
oat, 102
orchard, 227, 254
poultry, 411, 430
power, 450
raspberry, 263
rice, 110-112
sheep, 399, 409
small fruit, 257, 272
soils, 38, 55
sorghum, 119-126
strawberry, 257
sugar beet, 204
sugar cane, 126-129
swine, 325, 342
tobacco, 219, 226
trial, 2
wheat, 84-101, 117
woodland, 319, 323
Propagation, grape, 269, 270
propping *vs.* wiring, 248, 250
Pruning tree roots, 236
methods, 241
trees, 237, 240
Pump, barrel, 248
power, 249
Pumpkins, 299
Purebreds *vs.* grades, 330

Q

Queen bee, 435
clipping, 440
Queening, hive, 438
Questions, *close of chapters*

R

Rabbit injury, 248
Races of bees, 433
Radishes, 285
Rainfall map, 24
Ram, hydraulic, 447, 448
Rape, dwarf essex, 292
pasture, 332
Raspberry crown gall, 264, 265
enemies, 265
freezing, 265
intercropping, 264
locations, 263
marketing, 265
picking, 265
planting, 264
projects, 263
propagation, 263
pruning, 264
Raspberry, training, 265, 266
varieties, 263
Ratio, nutritive, 356, 357
Ration, balanced, 357
Rations, beef, 382
Receipts, livestock, 7
Records of projects, 3
Red clover, enemies, 162
regions, 161, 162
rotations, 161
seeding, 161
soils, 161
Red poll, 376
Red-top grass, 140
Regional map, 34
map, soils, 39
Regions, alfalfa, 149, 150
barley, 106
corn, 160
flax, 114
potato, 177
red clover, 162
rice, 111
sugar cane, 126
Registration, pig, 338
Registry, advanced, 363
of merit, 363
Renting plan, 6
Repairs, machinery, 459
Reports of projects, 3
Re-queening, hive, 438
Rhode Island Reds, 414
Rhubarb, 294
Rice enemies, 112
harvesting, 111
history, 117
preparation for, 111
projects, 110-112
regions, 111, 220
seeding, 111
soils, 111
watering, 111
Ridging machine, 194
Ridging potatoes, 182
Road, concrete, 313
drag, 313
drainage, 311
foundation, 311
good, 312
Macadam, 312
materials, 311
Roads, 310-313
permanent, 311
sand-clay, 313
Roller, 42
Rolling grain, 94
Root grafts, 231, 232
hairs, 29, 35

Root, pruning, 236
Roots need air, 36
uses of, 29
Rope work, 460-462
Rotations, alfalfa, 157
clover, 161
wheat, 86
Roughage, 357
Roup, 424
Rural community, 315
Rust, apple, 244, 246
grain, 96
Rye, disease, 110
grasses, 141
harvesting, 110
pasturing, 110
Rye, projects, 109, 110
seeding, 110
soils, 109
uses, 110

S

Saddle horses, 390, 392
Salesman farmer, 16
Salsify, 291
Samples, cotton, 206, 207, 217
grain, 117
Sand-clay road, 313
Sanitation, poultry, 423
poultry yard, 424
swine, 335
San José scale, 242
Saving seed, 60
Scab, apple, 244, 245
peach, 245
potato, 181, 195
School improvements, 316
Score card, potato, 188
swine, 329
Screenings, grain, 99
Seasons and plants, 33
Seed, alfalfa, 150, 155
analysis, 36
barley, 107
bed, tobacco, 220
bulletins, 37
clean, 91
corn, storage, 60
crimson clover, 166
flax, 116
formation, 131
inoculation, 151
investigations, 37
large, 36
plot, corn, 74
potatoes, 179
treating, 180, 181
Seed, questions, 36
selecting, 104
testing, 33, 36
tobacco, 220
treatment, 92, 103
weights and yields, 144
Seeding clover, 161
Seeding flax, 114
rice, 111
wheat, 90, 92
Seeds, age of, 32
garden, 279
impurities in, 33
matter in, 32
planting, rules, 284
saving, 32
Selecting cotton seed, 208
Self-feeder, 455
pollination, 30
Selling pigs, 338, 339
wool, 407
Separators, cream, 366
Septic tank, 313, 314
Setting strawberries, 259
Sharpening tools, 459
Shearing sheep, 407, 408
Sheep barn, 405
breeding, 404
charts, 409
coarse-wool, 402
Cotswold, 402
debates, 409
Dorset, 402
enterprise, 399
equipment, 45
exercises, 409
feeding, 404
fine-wool, 400
Hampshire, 402
investigations, 409
killed by dogs, 399
Leicester, 403
Lincoln, 403
medium-wool, 400
Merino, 400
panel, 406
problems, 409
projects, 409
questions, 409
shearing, 407, 408
Shropshire, 401
Southdown, 401
survey, 409
trips, 409
types, 399
Shelter, beef, 378
belts, 323

Shire horses, 387
Shop books and bulletins, 463
 charts, 462
 interior, 453
 investigations, 463
 projects, 452–462, each chap.
Shop questions, 463
 survey, 462
Shocking wheat, 97
Shorthorns, 373, 374
Showing pigs, 338, 339
Shropshire sheep, 401
Shrubs, native, 308
 per acre, 467
 uses, 305
Silage making, 79
Silo, underground, 130
Silos, 79
Sire, swine, 337
Sites, orchard, 228
Size *vs.* labor income, 11, 12
Skeleton, poultry, 426
Skinner system, 284, 299
Small fruit charts, 272
 debates, 272
 enterprise, 257
 exercises, 274
 investigations, 274
 problems, 272
 projects, 257, 272
 questions, 274
 survey, 271
 trips, 272
Small grain enterprise, 85–118
Smudges, 22
Smut treatment, 92
Sod culture, 237, 238
Soil amendments, 53
 books and bulletins, 56
 cracking, 49
 elements, 27, 28
 exercises, 51, 53, 54
 experiments, 53, 54, 55
 factors, 39, 40
 garden, 282
 improvement, 38, 40
 maintenance, 38, 40
 map, 39
 moisture, 23
 packing, 42, 51, 52, 282
 projects, 38–56
 references, 53, 56
 temperature, 22
 trips, 55
Soiling system, 358
Soils, alfalfa, 149, 152
 barley, 106, 107
Soils, clover, 161
 corn, 57
 cotton, 206
 flax, 114
 garden, 275
 grape, 268
 Irish potato, 177
 orchard, 227
 rice, 111
 rye, 109
 sorghum, 123
 sugar beet, 199
 sugar cane, 126, 127
 sweet potato, 191, 193
 tobacco, 219
 woodland, 323
Soldering, 457
Sophie's Agnes, 346
Sorghum, amber, 122
 charts, 130
 culture, 124
 debates, 131
 enemies, 124
 enterprise, 119
 fertilizers, 123
 gooseneck, 123
 grain, 119
 harvesting, 122, 124
 investigations, 131
 orange, 123
 planting, 123
 problems, 130
 projects, 119–126
 questions, 131
 regions, 119, 121
 soils, 123
 sumac, 123
 surveys, 130
 sweet, 122–126
 syrup, 125, 126
 uses, 122, 126
 yields, 125
Southdowns, 401
Sows, culling, 336
 number to buy, 330
 vs. gilts, 329
Soybeans, 169, 170
 with corn, 170
Spinach, 286
Splicing rope, 461, 462
Spray campaigns, 245, 255
Spray outfits, 248
Sprayers, 248, 249
 power, 272
Spraying aphis, 255, 298
 Bordeaux, 300
 grapes, 272
 potatoes, 186

Sprays, mixing, 247
Squashes, 298
Stackers, alfalfa, 158
Stacking or not, 98
Standardbred horses, 390
Staple cotton, 206
Starch formation, 28
Steers, types, 379
Stem uses, 29
Stepping-stone plan, 8
Stockers, producing, 377, 378
Storage in seeds, 32, 37
in plants, 35, 36, 37
potato, 187, 188
sweet potato, 195, 196
Storing grain, 104
Stover, corn, 80, 81
Straw, burning, 98
Strawberry blossoms, 258
enemies, 261
field preparation, 257
hedgerow, 260
hill system, 260
life of, 263
location, 257
matted row, 260
mulch, 261
picking, 262
plants, 259
projects, 257
setting, 259
soils, 257
varieties, 258
Stripping tobacco, 225
Suckering tobacco, 223
Sudan grass, 142, 143
Sugar beets, 199, 202
and mangels compared, 202, 203
charts, 202
culture, 201
debates, 204
farm, 200
harvest, 201
investigations, 204
planting, 200
problems, 203
projects, 204
questions, 204
regions, 199
soils, 199
survey, 203
thinning, 203
trips, 203
varieties, 199
Sugar cane cultivation, 128
enemies, 129
harvesting, 129
Sugar planting, 127
projects, 126–129
regions, 126
soils, 126, 127
Sugar exercise, 51
from beets, 202
Sunlight, 28
for plants, 36
Survey, alfalfa, 159
bee, 441
beef, 383
close of chapters
clover, 167
corn, 81
cotton, 217
dairy, 370
garden, 301
grain, 116
grass, 145
horse, 395
legume, 175
orchard, 253
potato, 188
poultry, 429
power, 450
sheep, 409
shop, 462
small fruit, 270
sorghum, 130
sugar beet, 203
sweet potato, 196
swine, 341
tobacco, 226
woodland, 321
Swarm prevention, 440
Swarming bees, 440
Sweet clover, 158
pasture, 332
Sweet potato bed, 193
chart, 197
culture, 194
debates, 197
diseases, 194
enterprise, 191
exercises, 198
fertility, 191
harvest, 195
insects, 195
plants, 192
problems, 196
projects, 191–198
questions, 198
regions, 191
soils, 191, 193
storage, 195, 196
survey, 196
transplanting, 193

Sweet potato, trips, 197
varieties, 191, 192
Swine breeding, 337
butchering, 342
charts, 342
cholera, 335
enterprise, 325
equipment, 453, 454
exercise for, 335
exercises, 342
feeds, 332, 333
fence, 331
house, making, 455
housing, 333
investigations, 342
lice, 335
pastures, 330, 331
problems, 341
projects, 342
questions, 342
sanitation, 335
score card, 329
securing, 328
selecting, 325, 326
self-feeder, 455
survey, 341
types, 325
Swiss chard, 291
Symbiosis, 52
Syrup vat, 125
hydrometer, 127
making, 126
System in farming, 16

T

Tamworth, 328
Teaching by projects, 1
Teeth of horse, 396
Temperature exercises, 36
Temperatures for growth, 22
soil, 22
Tenants *vs.* owners, 7
Tenantry, 6
Tent caterpillars, 241
Terracing, 52–55
Tester, rag-doll, 66, 67
Testing corn, 66, 67
cows, 361, 362
eggs, 419
seeds, 33, 36
soils, 44, 56
Thoroughbreds, 389
Thrashing barley, 108, 109
from shocks, 98
grain, 99, 104
rye, 110
Tillage, 40, 41, 49, 73–75
implements, 240
plan, annual, 238
Timothy, curing, 136
for hay, 136
growing, 135–137
seeding, 136
Tobacco barn, 225
by countries, 221
culture, 222
curing, 224
diseases, 223
enterprise, 219
exercises, 226
field preparations, 222
grading, 225
harvesting, 224
insects, 223
investigations, 226
marketing, 226
prices, 226
priming, 223
projects, 219–226
questions, 226
regions, 220
seed bed, 220
seed, 220
setting, 222, 223
soils, 219
stripping, 225
suckering, 223
surveys, 225
topping, 222
trips, 226
types, 219
yields, 226
Tomatoes, 299
Tool sharpening, 460
Topical method, 5
Topping tobacco, 222
Tractors, uses, 449
Training raspberries, 265
Transpiration, leaf, 36
Transplanting, 282, 283
machine, 223
sweet potatoes, 193
tobacco, 222
Treating potatoes, 180, 181
Tree planting, 267
pruning, 237, 240
varieties, 320
Trees, banked, 239
Tree, heeling in, 235
orchard, 229
ornamental, 306
woodland, 319
Trellising grapes, 269, 271

Truog tester, 44
Tuberculosis, cattle, 360
  tests, 361
Turnips, 288
Types and varieties, tobacco, 219
Types, barley, 107, 108
  corn, 61, 62
  cotton, 205, 206
  farming, 9
  oats, 102, 103

U

Udder, clipping, 364
  cows, 365
  dirty, 365

V

Valve action, 446
Varieties, alfalfa, 149
  mixing, 320
  of cotton, 207
  orchard, 228
  potatoes, 179
  sugar beet, 199
  sweet potato, 191, 192
Variety characteristics, corn, 64
  poultry, 415
Vegetables, cost of, 9
  labor in growing, 10
Velvet bean map, 121
  beans, 175
  beans in corn, 72
Vetch and rye, 171
  inoculated, 172
Vetches, 170, 171
Vines, uses, 305
Vinifera grapes, 268
Vitamines, 64, 369, 370

W

Walks, 310
Warm-season crops, 294–300
Wastes, farm, 14
Water for ornament, 305
  forms of in soil, 23
Watering rice, 111, 112
Watermelons, 296
Water system, 457, 459
  wheels, 444
Weaning pigs, 336
Weed descriptions, 473
Weeder, one-horse, 212
  on potatoes, 182
Weed seeds, 474, 475
Weevil, strawberry, 261
Weighing milk, 361
  wheat, 101
Wheat breeding, 100
  cross-section, 117
  grading, 100, 101
  harrowing, 93
  harvester, 97
  history, 100
  implements, 89, 90
  insects, 94–96
  pasturing, 93
  planting, 90, 91
  preparation for, 88
  projects, 85–101
  recleaning, 99
  regions, 85–87
  rolling, 94
  rotations, 86
  screenings, 99
  soils, 85, 88
  thrashing, 98, 99
  types, 86, 89
Wheat yields, 99
White clover, 166
Windbreaks, 321
Winter study of corn, 67, 68
Wiring fruit trees, 248, 250
Woodland charts, 323
  debates, 323
  enterprise, 319
  exercises, 323
  investigations, 324
  problems, 323
  projects, 319–323
  questions, 324
  shelter, 323
  survey, 322
  trees, 319
  trips, 323
Wool, selling, 407
Wyandottes, 414

Y

Yellows, peach, 245
Yields of corn, 79, 80
  tobacco, 226
Yorkshire, 328

32458
12 FEB